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"CONSUMER BRAKING INFORMATION – FINALIZE TEST PROTOCOL – PHASE I"

TRANSPORTATION RESEARCH CENTER INC.
10820 State Route 347
East Liberty, Ohio 43319

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FINAL REPORT

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U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Office of Crash Avoidance Standards, NVS-122
400 Seventh Street, SW
Washington, DC 20590

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1.0 ABSTRACT

The purpose of this testing titled, "Consumer Braking Information – Finalize Test Protocol," is to investigate vehicle testing and test surface specification issues that will enable NHTSA to address several public comments received following the request for comments notice and to bring NHTSA closer to finalizing the test protocol.

2.0 BACKGROUND

This test program was initiated by the National Highway Traffic Safety Administration (NHTSA) as part of an ongoing effort to establish a braking performance measurement test procedure for light vehicles. NHTSA intends to present the resulting braking performance information to vehicle consumers through the New Car Assessment Program (NCAP).

In the first phase of this program testing was performed at Aberdeen Test Center where a preliminary test procedure was developed and a study was performed on testing variability. In the second phase a round-robin test was performed to further study testing variability, this time associated with testing vehicles at different test tracks and with different test drivers.

On July 17, 2001, NHTSA published a request for comments notice on the draft test protocol. Public comments were solicited and were received addressing the agency's consumer braking information program, including the draft test protocol. Test reports for the first two phases of testing, the request for comments notice and the comments received can be accessed at http://dms.dot.gov under NHTSA docket number 1999-6583.

On September 23, 2002, NHTSA authorized further testing at Transportation Research Center Inc (TRC Inc.).

3.0 OBJECTIVE

The purpose of this testing titled, "Consumer Braking Information – Finalize Test Protocol," is to investigate vehicle testing and test surface specification issues that will enable NHTSA to address several public comments received following the request for comments notice and to bring NHTSA closer to finalizing the test protocol.

This work is divided into two distinct phases. In Phase I, a total of eight vehicles have been tested with the intent of satisfying the objectives of the first five tasks. These tasks are:

a) Task 1 – Investigate Initial Brake Pedal Application Criteria.
b) Task 2 – Investigate Steady-State Brake Pedal Force Criteria.
c) Task 3 – Investigate and Recommend Pass/Fail Brake Pedal Force Corridor, and Associated Driver Display System.
d) Task 4 – Perform Statistical Analysis of Stopping Distance Results.
e) Task 5 – Perform Evaluation of Test Surface and Environmental Conditions.

This test report covers the work of Phase I. Phase II work is to consist of the prototype testing of 36 vehicles and is not covered in this report.

4.0 VEHICLE ACQUISITION AND PREPARATION

In support of this program, eight vehicles were rented or otherwise acquired that were equipped with four-wheel anti-lock brakes. The vehicles were Model Year 2002 or newer with low mileage. Vehicles were equipped with original or OEM replacement brake components that were burnished through normal usage. Tires were original or OEM replacement with at least fifty-percent of tread remaining.

Each vehicle was instrumented in accordance with FMVSS No. 135 compliance test procedure PT-135, version 10/29/97, with some minor exceptions. Instrumentation included the installation of K-type thermocouples in the outer front brake linings, a calibrated non-contact fifth-wheel, brake force pedal transducer, decelerometer, data recorder, and driver displays. In addition, the brake light switches were monitored in several vehicles for specific use in Task 1. Instrumentation related to parking brake force and individual wheel speeds was not installed.

The vehicle curb weights were recorded and vehicles were ballasted to a lightly loaded condition (curb weight plus 400 lbs.) as specified in FMVSS No. 135. This was achieved by adding sandbag ballast to the front passenger seat area. Ballast was readjusted for each test driver.

5.0 TEST SITE CONDITIONS AND PREPARATION

Testing was conducted on an asphalt lane located on TRC's Vehicle Dynamics Area. The asphalt lane is located at the south end of the VDA and north of the Jennite-coated test surface, and runs roughly West to East across the VDA. Drivers may utilize a curved and banked roadway to gain speed before entering the lane when necessary. The area selected has a one-percent drainage slope laterally (North to South) and no slope longitudinally.

The test surface had an installed Peak Coefficient of Friction (PFC) of 1.03 dry and 0.94 wet. The test lane was burnished by dragging the locked tires of a loaded semi-trailer along the lane until the PFC was reduced into the acceptable range of 0.90-0.95 dry and 0.80-0.85 wet.

For wet stops, water is applied between each test run with a water truck. It is difficult to accurately measure water depth, but there is no standing water in the test lane.

Weather conditions are monitored and recorded by a permanent weather station located on TRC's control tower also located at the Vehicle Dynamics Area. Surface temperature measurements were taken with a hand-held infrared device.

6.0 TASK 1 – INVESTIGATE INITIAL BRAKE PEDAL APPLICATION CRITERIA

In previous testing by Aberdeen Test Center, it was made clear that initial brake pedal force is critical in ensuring repeatable stopping distances. The Aberdeen report indicates that 500 N of pedal force must be applied in 0.25 seconds if repeatable distances are to be achieved. The testing that led to this pedal force application rate was performed utilizing the vehicle's brake light switch to trigger the beginning of the stop event. This practice may or may not be reliable as performance of the switch, stiffness of the mount, etc., may influence the exact timing of switch closure. In addition, as was noted in NHTSA's request for public comment, it is common to see large pedal force values at time-zero; from 50 to 130 N in the Aberdeen work.

In order to investigate the effects of the different stop triggering techniques on the measured stopping distance TRC Inc. triggered each stop using a brake pedal force transducer and also recorded the state of the stop lamp switch. In the majority of the vehicles tested the pedal force threshold led the activation of the stop lamp circuit by one sample period, or 0.01 seconds. The Nissan Maxima exhibited a lag time of two sample periods, or 0.02 seconds. At 100 Kph this represents a potential difference in measured stopping distance of 0.27 meters and 0.55 meters, respectively. While the lag time was consistent for each vehicle during its testing period, the variability from vehicle to vehicle is of concern.

It was noted in review of the stop-triggering data that initial pedal forces of 50 N and higher were noted at time zero regardless of the triggering method. The rate of brake pedal application requires that the driver's foot strike the pedal aggressively. At a sampling rate of 100 Hz, forces lower than 50 N at time zero are rare. Though this answers the question of high time-zero pedal forces when using the stop lamp circuit to trigger stop events, the time variability addressed above indicates that triggering from a pedal force threshold is a preferable process.

In this round of testing the stop event begins when the transducer output exceeds 6 N. This threshold was chosen because it is suitably high to limit false triggering due to road noise and is still less than the amount of force required to move most brake pedals from their stops. In previous testing, TRC Inc. has had success with thresholds as low as 5 N. Review of the current test data suggests that a threshold of between 4 N and 10 N (and perhaps higher) would have been acceptable.

Because of this experience TRC Inc. recommends triggering the stop event when the pedal force exceeds 5 N.

The time required to reach 500 N in each vehicle varied slightly, but an application rate of 0.25 seconds was easily achieved in all cases. Review of the data revealed that when apply rates of greater than 0.5 seconds were eliminated, it was common to see average apply rates of 0.06 to 0.15 seconds when the driver was asked to target either 500 or 670 N steady state force. No direct correlation between stopping distances and pedal force apply rates was apparent as long as the rate of apply was faster than 0.25 seconds.

There was no consistent difference in initial pedal force between wet and dry stops. The driver's instruction – to quickly apply the steady state force and maintain it until the vehicle stops – leads to ABS activation regardless of the surface coefficient. The driver, in this case, is applying force as quickly as possible and allowing the ABS to control the nature of the stop. Anticipation of surface condition does not influence pedal force application rate in this testing situation.

In summary, TRC Inc. recommends the following:

- Triggering of the stop event should be done with an external pedal force transducer.
- The trigger threshold for the stop event should be 5 N.
- NHTSA's suggested time to reach 500 N of pedal force of 0.25 seconds is easily achievable in all vehicles tested. The faster rate of 0.15 seconds is also achievable. As there is no clear advantage to either rate, TRC Inc. recommends the least restrictive rate of 0.25 seconds.

7.0 TASK 2–INVESTIGATE STEADY STATE BRAKE PEDAL FORCE CRITERIA

The Aberdeen testing was performed using 670 N as a steady state pedal force target with a tolerance of plus or minus 70 N. This level proved easily achievable for TRC Inc.'s trained and experienced test drivers in most of the vehicles tested. The test data showed that reliable, repeatable stops could be achieved within these parameters. Drivers could achieve steady state by 0.75 seconds reliably. The key to the driver's ability to perform at this level seems to be that it is a considerable physical effort to reach the target force, and that very little fine control of the force is required.

As requested TRC Inc. Also investigated 500 N as a force target. Drivers had also tested to this target, as a maximum allowable force in FMVSS 135, and were familiar with it. They reported, however, that it was more difficult to achieve the required steady-state force within a reasonable amount of time. The drivers reported having to "pull back" the force, meaning that restraint was required to not apply more force than allowed. In the stops performed at the 500 N steady state force level the drivers were less successful in keeping force constant throughout the

stop. With practice it is expected that drivers will be able to maintain closer tolerances at the 500 N force level. A public comment on the subject suggests a tolerance level of +/-30 N would be appropriate. TRC Inc. agrees with NHTSA that there may be a threshold of force required to initiate ABS brake cycling in most vehicles and that the pedal force input should exceed this threshold. Without knowing what lower level of force is appropriate for any given vehicle TRC Inc. accepts NHTSA's suggestion that the lowest allowable steady state pedal force for most vehicles should be 470 N, or 500 N minus 30 N. In the interest of allowing the test driver some margin of error in the performance of the testing task, however, TRC Inc. recommends an upper limit for 500 N stops of 550 N, or 500 N plus 50 N.

The Chevrolet Silverado 2500 HD, tested as NCAP 6, was equipped with a hydraulic brake booster and proved difficult to control in terms of brake pedal force. Under "normal" application the pedal felt soft but acceptable. Under rapid application, however, the pedal would travel rapidly towards the floor requiring the driver to "chase" the pedal. During the first test stop the driver was surprised by this and was able to achieve an initial pedal force of 500 N in 0.05 seconds, but took until approximately 0.8 seconds to "catch" the pedal and reapply force. Steady state in this stop ranged from 50 to 150 N. Interestingly, the stopping distance of 60.2 m was under the average for all stops in that test. In the interest of completing a vehicle test, some allowance in the test protocol should be considered for vehicles that are difficult to test to a tolerance level.

The suggested brake force corridor requires the driver to exceed 500 N within 0.25 seconds, and to achieve steady state at 0.75 seconds. Steady state is defined at present as 500 N plus 50 N, minus 30 N. Some vehicles may gain an advantage in stopping distance if the steady state pedal force exceeds the upper threshold. Clearly this should not be allowed. However, no clear advantage exists to supplying less pedal force than the protocol requires. Therefore, vehicles that can be tested within the upper threshold but that still fall outside the lower threshold can be said to have been fairly tested under this protocol. The manufacturer of a specific vehicle may, however, object if the vehicle performs below expectations. In the interest of fairness then, some special accommodations should be in place.

Vehicles NCAP 1 through NCAP 4 were tested at 500 N only due to a programming error in the data acquisition system. Vehicles NCAP 5 through NCAP 101 were tested at both 500 N and 670 N steady state force levels. Average stopping distances, after removing outliers, are as follows:

		STOPPING DISTANCES			
		500 N PEDAL FORCE		670 N PEDAL FORCE	
Vehicle Number	Vehicle Model	Dry	Wet	Dry	Wet
NCAP 5	Ford Taurus	51.4 m	58.4 m	51.5 m	57.00 m
NCAP 6	Chevrolet Silverado	53.0 m	60.4 m	52.5 m	62.2 m
NCAP 7	Nissan Maxima	47.4 m	49.8 m	46.2 m	49.8 m
NCAP 8	Chrysler Caravan	48.0 m	55.0 m	47.2 m	54.5 m
NCAP 9	Ford Focus	47.5 m	51.6 m	45.5 m	50.3 m
NCAP 10	Ford Windstar	49.8 m	55.3 m	48.4 m	55.3 m

It is not clear from this data whether either steady state pedal force level results in consistently shorter stopping distances for all of the tested vehicles.

Based on the testing performed in this and previous rounds of testing TRC Inc. recommends the following:

- As there is no clear advantage to testing at either force level and in the interest of harmonization with other Federal and International testing standards, TRC Inc. recommends 500 N as the steady state pedal force target.
- As the 500 N steady state force target may be approaching the lower limits of possible ABS activation thresholds and with a desire to present the test driver with an achievable test protocol, TRC Inc. recommends an allowable steady state testing tolerance of 470 N to 550 N.
- Based on TRC Inc.'s experience with vehicle NCAP 6, some consideration should be given to the testing of vehicles with brake systems that meet appropriate FMVSS, but are difficult test with respect to the NCAP pedal force tolerance. TRC Inc. recommends that the testing agency should contact NHTSA if after three stops the vehicle seems to be non-conforming with the test protocol. The testing agency should provide data from those stops to NHTSA for review. At NHTSA's discretion the manufacturer may be contacted for a remedy with a fixed date on which it must respond. If NHTSA finds the remedy unacceptable or if the manufacturer fails to respond on time, the test should continue. The driver will then make his/her best effort to comply with the protocol without exceeding the steady-state upper pedal force threshold and the next ten stops that meet all other (non-pedal force related) criteria should be used for scoring. The recommended maximum of fifteen stops would still apply. The consumer data should carry a standardized disclaimer regarding the special testing situation.

8.0 TASK 3-INVESTIGATE AND RECOMMEND PASS/FAIL BRAKE PEDAL FORCE CORRIDOR AND ASSOCIATED DRIVER DISPLAY SYSTEM

In Tasks 1 and 2, TRC Inc. expressed a preference for an initial pedal force rate of 500 N in 0.25 seconds and a steady state pedal force of 470 N to 550 N. NHTSA's suggested definition of steady state is the period from 0.75 seconds after brake application until the vehicle comes to a complete stop. The Agency requests a Cartesian coordinate system plot of pedal force against time with shaded regions representing the initial pedal force ramp-up and the final steady state regions. The Pedal Force Corridor Plot derived from Tasks 1 and 2 is located in Appendix G.

The driver display used during testing for this program consisted of a "heads up" digital bar graph system and numerical displays. The driver sees vehicle speed numerically and two bar graphs of pedal force on the heads up display. The upper bar graph is scaled from zero to twice the target pedal force, placing the target force in the center of the bar. The lower bar is scaled to the tolerance values, again placing the target force in the center of the graph. The driver uses the upper bar for the ramp-up phase and watches for activity in the lower bar. The driver attempts to keep the lower bar lit to the center, knowing that as long as the bar is neither dark nor fully lit he/she is in the target range. Separately, on a laptop computer display, the driver can see initial and instantaneous brake lining temperature, stopping distance, stop speed, average deceleration, and a graph of the previous stop. Once the driver enters any stop comments into the system the heads up display shows speed and pedal force, allowing static practice between stops.

This display configuration is a modification of the display system drivers have used at TRC for FMVSS 105, 121, and 135 brake testing for several years. Drivers have expressed a preference for indicator displays over purely numerical displays. It is difficult to follow trends in numerical displays, such as a ramp-up of pedal force or deceleration, because the driver must process the numerals before he/she can understand what to do based on them. The indicator display, on the other hand, is intuitive: more light indicates more force. A limiting factor of an indicator display is the visual resolution. The standard heads up display used is limited to 80 LED segments over eight inches of space. For a 670 N display with 670 N as the center point this gives a resolution of 16.75 N per segment which is adequate for the ramp-up phase. When this same display is used to represent just the allowable range, 140 N for the 670 N testing, the resolution jumps to 1.75 N per segment. This range is far better for precise targeting.

Drivers reported that they were able to use the dual bar graph display effectively for the 670 N stops, but that during the 500 N stops the lower band was too narrow and was distracting to watch. Review of pedal force data showed that the drivers had difficulty staying within the suggested tolerance of +/-30 N, often oscillating around that tolerance, which would have made the lower bar difficult to trend. Adjusting the lower display for a wider band may have been helpful for the driver.

9.0 TASK 4–PERFORM STATISTICAL ANALYSIS OF STOPPING DISTANCE RESULTS

One of the challenges faced by the Consumer Braking Information Program that was identified during the public comment period is the actual presentation of stopping distance information. The number of test stops to be made, the data to be presented (average, standard deviation, 95th confidence interval, etc.), and the statistical significance of any of these were called into question during the comment period. Though most comments indicated that only average values should be presented, NHTSA has requested a statistical analysis of the stopping data collected by TRC Inc. and that TRC Inc. provides recommendations for the future program.

The Aberdeen testing and much of the TRC Inc. testing included one set of ten stops per vehicle condition. Where possible, additional sets of 10 stops were performed for a total of twenty stops per vehicle. For this analysis, no stops were omitted for having not strictly met the proposed steady state pedal force requirements (500 N +/- 30 N or 670 N +/- 70 N). All but a few stops met the initial pedal force application rate requirements suggested by NHTSA and in some public comments (0.25 seconds and 0.15 seconds, respectively, to reach 500 N). Regardless, this investigation is not intended to characterize any particular vehicle, but is intended to examine statistical approaches one might use to rate vehicle performance in future testing.

The simplest statistical approach is the average. The average represents the mathematical center of a set of data points; in this case vehicle stopping distances. Assuming no data points are obviously problematic (test parameters not met, mechanical problems, driver error, etc.), one simply includes all data points in the calculation. The average is useful and is easily understood. Difficulty arises when outliers occur in the data. Then one must decide if a single data point (or more) influences the average in some meaningful way and if that influence is tolerable. One might argue that if the data was taken following the test protocol and no test element disqualifies the point, the average should include that point. For purposes of this analysis, any data point five or more meters from the raw average of all stops in the set has been removed. Finer grooming of the data set can be performed, but first one must decide on a finer definition of an outlier. For example, the procedure for measurement of pedal friction coefficient (PFC), discussed further in Task 5, considers any data point more than .05 away from the average to be an outlier. This represents a difference of five percent of a nominal best coefficient of 1.0.

The significance of the average and its usefulness in understanding and predicting future stopping performance of the vehicle is aided by inclusion of the standard deviation. Though more obscure to the public, the standard deviation is reasonably simple to explain and is powerful. The standard deviation represents the spread of data points included in an average and is presented in the same units as the average, which in this case is in meters. If the average stopping distance is

relatively low and the standard deviation is also relatively low, the consumer might reasonably expect that vehicle to perform at the level of the average a large percentage of the time. If for that same low average the standard deviation is high, the consumer might expect that his or her stopping distance might vary greatly from the average number.

A related measure of adherence to an average is the confidence interval. Here, as is often the case, data is presented as the 95th confidence interval. In the simplest terms, the 95th confidence interval suggests that 95 percent of the time one might expect new data to fall within a certain range of the already collected data. A 95th confidence interval of .010 would suggest that new data would fall within 10 percent of the average value 95 percent of the time. This information can be useful and powerful, but may not be as easily understood as the standard deviation. As suggested during the public comment period, samples larger than 10 stops assist in the valid formation of confidence intervals.

In the statement of work for this program, NHTSA referenced the 95th percentile as being a potential statistic to report and comment upon. TRC Inc. has compiled the 95th percentile of each data set, though it is understood that examination of the 95th confidence interval was the actual intention of the agency. The 95th percentile is a representation of a value below which 95 percent of the data points fall. In terms of stopping distances, the 95th percentile would represent a much higher than average figure, a distance that likely would only be exceeded five percent of the time.

The test data collected at TRC Inc. for this program has been analyzed and the results are presented in an appendix following this report. TRC Inc. has compiled the statistics and the following parameters are presented:

- Raw Average, including all data points collected.
- Average, after removal of outliers (data points 5 m away from Raw Average).
- Standard Deviation.
- 95th Confidence Interval.
- 95th Percentile.

The above statistical figures were determined for data sets including:

- Sets of ten stops.
- First five stops (after removing outliers).
- Last five stops (after removing outliers).
- Sets of twenty stops where applicable.

In the case of sets of five stops where data points have been removed from the original group of ten, the same data points can be represented in both the first and last five point statistics.

Review of the average data, after removing outliers, reveals a fairly obvious point. Sets of ten or twenty stops with a larger standard deviation yield large differences in averages when the sets are broken into smaller sets for analysis. Vehicle NCAP 3 showed an average stopping distance of 57.34 meters in the dry testing at 500 N. When this test set of twenty stops is broken into sets of first and last ten stops the resulting average is 57.22 m and 57.45 m. This difference is well within the original standard deviation of 1.69 m. However, when the first ten stops are further broken down into sets of first and last five the averages are 58.58 m and 55.86 m, a difference of 2.72 m. Other data sets contain similar discrepancies depending on how the data sets are broken out. The magnitude of the standard deviation of the larger set suggests the magnitude of the differences between data subsets, but there is not a consistent relationship between the two.

The one consistent trend seen from this data is that if the average is to be relied upon, a larger data set is preferable. There is a smaller data spread between ten-stop data sets of the same vehicle than there are between some five-stop data sets. There is less spread between the averages of ten-stop and twenty–stop data sets. TRC Inc. recommends that the average of ten stops, after removing outliers, should be used for reporting of stopping distance data. The magnitude of qualification as an outlier should be fairly large, on the order of five to ten percent of the raw average, to ensure inclusion of true vehicle variability in the results.

Standard deviation is an interesting statistic. In dry conditions the standard deviation for most vehicles was less than one meter. In wet conditions the standard deviation was typically between one and two meters. This information, expressed in meters, could be very helpful to the consumer. Similarly the 95^{th} confidence interval may be presented in such a way as to be well understood by the consumer. The confidence interval, as has been suggested, may not be technically correct for a population of ten stops, and is less familiar to consumers. TRC Inc. recommends that standard deviation should be included in the test results only if presented in a manner that relates directly to consumer experience.

TRC Inc. recommends the use of ten stops per condition as a reasonable number for this program. As driver error, environmental conditions, and other disturbances can be expected to affect some stops, it would be useful to have a larger number of allowable stops than the number of required stops. TRC Inc. recommends that up to fifteen stops should be allowed and that the first ten meeting the criteria of the protocol be used for determination of stopping performance.

The statistical analysis of stopping distance is found in the appropriate appendix at the end of this report.

10.0 TASK 5 – PERFORM EVALUATION OF TEST SURFACE AND ENVIRONMENTAL CONDITIONS

The NCAP Consumer Braking Information test pad was defined on TRC's Vehicle Dynamics Area (VDA) and the surface friction was determined using the TRC Inc. Area Reference Skid Measurement System (ARSMS) skid trailer in accordance with ASTM E 1337-90 "Standard Test Method for Determining Longitudinal Peak Braking Coefficient of Paved Surfaces Using a Standard Reference Test Tire."

Following NHTSA's preference for describing the peak surface characteristic as "Peak Friction Coefficient" (PFC) TRC Inc. will use this terminology in place of the ASTM's "Peak Braking Coefficient" (PBC). The Peak Friction Coefficients (PFC), both dry and wet, were determined periodically throughout the program. Since the objective of the PFC tests was to monitor pavement changes during the program, the wet PFC tests were conducted using water supplied by the ARSMS on-board water system that delivers a consistent and known volume of water for each test. Beginning with the June 30, 2003 data, the PFC was also determined using the water truck as it was used to provide a wet test surface for the brake testing. This additional testing was done to investigate the potential variability of water delivery from the water truck.

Each PFC result is the average of ten data points, five in the left wheel path (LWP) and five in the right wheel path (RWP). The five data points of either wheel path were distributed approximately equally down the wheel path. The ten data points were reviewed for outliers per ASTM E 274-97 "Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire." Following the elimination of outliers, the average and the standard deviation (SD) were calculated. The data are summarized in Table 5.1 and Figure 5.1. The raw data showing the outliers eliminated are provided in Appendix I.

Table 5.1

PFC and Surface Temperature Data

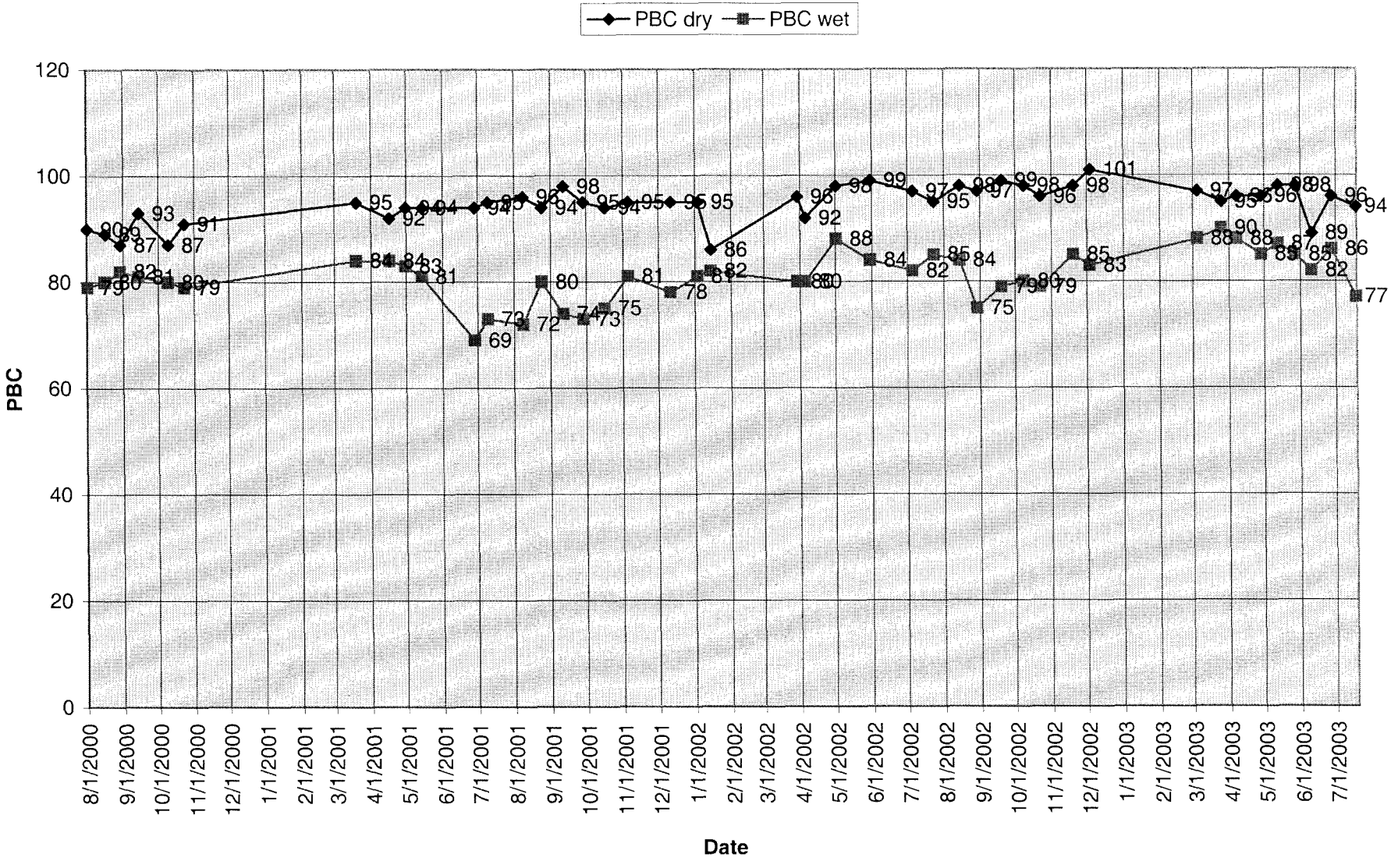
Test Dates	3-21	3-26	5-1	5-19	5-27	6-10	6-30	7-21	7-31	8-20
PFC										
DRY	0.96	0.93	0.95	0.96	0.94	0.93	0.94	0.95	0.95	0.96
SD	0.014	0.023	0.021	0.027	0.037	0.032	0.026	0.020	0.017	0.018
WET	0.84	0.83	0.79	0.83	0.83	0.82	0.83	0.87	0.82	0.80
SD	0.034	0.008	0.018	0.021	0.032	0.027	0.024	0.044	0.023	0.029
Water truck	NA	NA	NA	NA	NA	NA	0.85	0.78	0.78	0.82
SD*							0.023	0.017	0.018	0.033
T_s°F	61/58	73	87	90	67	84/81	76/80	93	80	73

*Water truck standard deviation was 0.085, 0.089, 0.059 and 0.053, respectively before removal of the outliers.

As can be observed from the PFC data presented and contrary to some of the comments received, the surface PFC does vary with time. There does not appear to be a relationship with surface temperature nor does there appear to be a relationship between dry and wet values. The raw data shows the pavement to exhibit non-uniform PFC values as one travels down a wheel path. Comparing data from the same individual location shows day-to-day variation in PFC values. This variation in PFC at the tire/surface interface is caused by any one or all of several variables. These include paver operations, aggregate polish, asphalt/aggregate surface volume, surface temperature, rubber build-up, surface contaminants from rain or lack of rain, tire slip percent at the peak force point, and skid system variability. These variables need to be investigated to determine their contribution and efforts made to reduce the influence of the major variables. A literature review revealed no published information. This is probably due to the relative newness of peak-type testing and the fact that most of this testing is done by tire companies which do not publish their test results.

The variability of the ARSMS skid system has been evaluated. The ARSMS was used to acquire all data as well as using the same tire, driver, and system operator. Operating procedures have remained the same throughout the program. On a test consisting of ten runs over the same wheel path and initiating the test at the same longitudinal point, i.e., test the same piece of pavement ten times, results in a standard deviation of 0.010 PFC for dry tests and 0.016 PFC for wet tests. This agrees well with the standard deviation of two Skid Numbers (SN) as stated in ASTM E 274-97 and with the ARSMS data generated during the correlations of SN with many skid systems at the Evaluation and Field Test Center here at TRC.
Historically, no PFC data exists for this test pad. However, TRC Inc. has monitored their facilities since the beginning in the mid-seventies. Figure 5.2 displays the results from one of those pads since the last re-paving of the VDA. This pad is untreated asphalt of the same composition as the NCAP test pad and is located near the NCAP pad on the VDA. The results show the dry surface has an average value of 0.95 PFC with a standard deviation of 0.034 PFC and the values range from 0.86 to 1.01. The wet surface has an average value of 0.81 PFC with a standard deviation of 0.047 PBC and the values range from 0.69 to 0.90. As with all other skid data presented in this report, the ARSMS, driver, system operator, and operating procedure remained the same. The tire was always an SRTT but not the same tire throughout all the data presented. Wet tests were supplied by the ARSMS on-board water system. Data was acquired through the winter months whenever the surface temperature was above 40°F and the surface was free of ice and snow.

Figure 5.2 Pad 4 History



Skid trailers and ASTM E-1337 are the ideal device for determining the PFC of a pavement. ASTM was requested to establish this procedure by General Motors. General Motors found poor correlation between the SN value of a pavement and the stopping distance of an ABS equipped vehicle. GM had developed a test method that did provide better correlation and that method became ASTM E-1337. The data generated using this method should provide the best correlation available between the stopping distance of an ABS equipped vehicle and the available surface friction.

Each skid system has unique dynamic response characteristics and therefore will return different PFC values than another skid system when used to determine the PFC value of the same section of pavement. Therefore, if other skid systems are to be utilized in future related programs, a correlation process should be developed and included that program. This correlation process is in place for skid systems used to determine SN values of pavements and the ARSMS is the reference system for that correlation process.

The use of the fixed longitudinal slip test device has been suggested to determine the PFC value of a pavement section in hope that the variability of the individual measurements will be reduced. One problem inherent with the use of this type of device is what slip ratio is used. During the many thousands of PFC tests conducted using the ARSMS, the critical slip ratio, or percent slip at the peak, varies for each test result. The percent slip is a variable of which very little public information is available. Since the fixed slip type device maintains a mechanically controlled (gear ratio) amount of slip throughout a test, the chance of the operating slip ratio being the critical slip ratio would seem to be very small. Therefore, the PFC, related somewhat to the slip ratio, determined using this device could be incorrect. Further research is required in both the relationship of PFC to slip ratio and alternative devices.

APPENDIX A

Test Vehicle Data Sheets

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

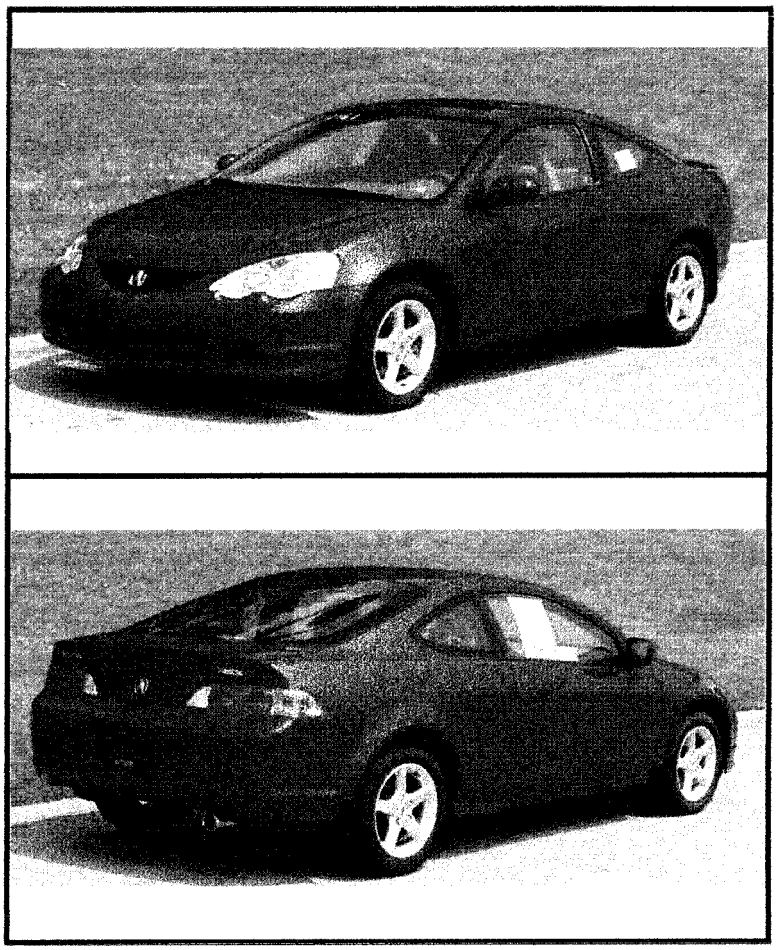
Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP1
VIN #	JH4DC53082C039341
Model Year	2003
Manufacturer	Honda Motor Co. Ltd.
Vehicle Model	Acura RSX Type S
Body Style	2Dr Coupe
Wheelbase	101.2"
Mileage (SOT)	2907

Drivetrain	
Engine Type	I4
Displacement	2.0L
Transmission	6M
Driven Axle(s)	FWD

Brake Package	
Front	Disk
Rear	Disk
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	16x6.5JJ
Wheel Type	Alloy
Tire Make	Michelin
Tire Model	Pilot HX MXM4
Tire Size	P205/55R16



Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.261	33 Psi
Right Front	0.265	33 Psi
Left Rear	0.268	31 Psi
Right Rear	0.262	31 Psi

Curb Weight	Front	1702 lb
	Rear	1087 lb
	Total	2789 lb
Tested Weight (Curb + 400 lb.)	Front	1930 lb
	Rear	1260 lb
	Total	3190 lb

Comments:

Recorded by: Dennis Grisez / Rob Neely Date: 05/22/2003

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP2
VIN #	1G2HX52K134161565
Model Year	2003
Manufacturer	Pontiac
Vehicle Model	Bonneville SE
Body Style	4Dr Sedan
Wheelbase	112.2"
Mileage (SOT)	2449

Drivetrain	
Engine Type	V6
Displacement	3.8L
Transmission	4spd Automatic
Driven Axle(s)	FWD

Brake Package	
Front	Disk
Rear	Disk
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	16X7J
Wheel Type	Alloy
Tire Make	Firestone
Tire Model	Affinity
Tire Size	P225/60R16

Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front		30 Psi
Right Front		30 Psi
Left Rear		30 Psi
Right Rear		30 Psi

Curb Weight	Front	2200 lb
	Rear	1420 lb
	Total	3620 lb
Tested Weight (Curb + 400 lb.)	Front	2450 lb
	Rear	1570 lb
	Total	4020 lb

Comments:

Reliable tread depth measurements were not taken. The vehicle had fewer than 2500 miles at start of test and had been at TRC since new.

Recorded by: Dennis Grisez / John Kaczar Date: 05/22/2003

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP3
VIN #	1GNEK13T71J234375
Model Year	2002
Manufacturer	Chevrolet
Vehicle Model	Tahoe LS
Body Style	MPV
Wheelbase	116.0"
Mileage (SOT)	17206

Drivetrain	
Engine Type	V8
Displacement	5.3L
Transmission	Automatic
Driven Axle(s)	4WD

Brake Package	
Front	Disk
Rear	Disk
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	16x6.5J
Wheel Type	Alloy
Tire Make	Firestone
Tire Model	Wilderness LE
Tire Size	P265/70R16

Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	.310"	35 Psi
Right Front	.345"	35 Psi
Left Rear	.331"	35 Psi
Right Rear	.300"	35 Psi

Curb Weight	Front	*
	Rear	*
	Total	5340 lb
Tested Weight (Curb + 400 lb.)	Front	3077 lb
	Rear	2658 lb
	Total	5735 lb

Comments:

* Individual front and rear curb weights were not obtained.

Recorded by: Dennis Grisez / John Kaczar Date: 05/22/2003

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

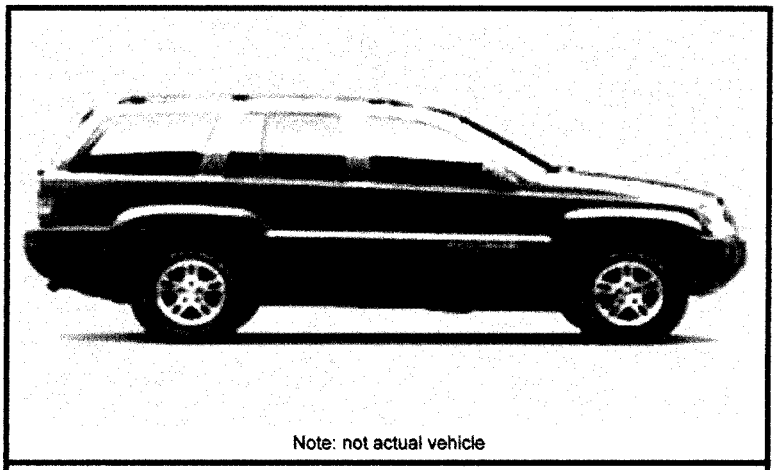
Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP4
VIN #	104GW485530616123
Model Year	2003
Manufacturer	Daimler Chrysler Corp
Vehicle Model	Grand Cherokee Laredo
Body Style	MPV
Wheelbase	105.90"
Mileage (SOT)	19984

Drivetrain	
Engine Type	I6
Displacement	4.0L
Transmission	Automatic
Driven Axle(s)	4WD/RWD

Brake Package	
Front	Disk
Rear	Disk
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	16x7.0
Wheel Type	Alloy
Tire Make	Goodyear
Tire Model	Wrangler ST
Tire Size	P22575R16



Note: not actual vehicle

Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.240"	33 Psi
Right Front	0.284"	33 Psi
Left Rear	0.232"	33 Psi
Right Rear	0.252"	33 Psi

Curb Weight	Front	1860.0 lb
	Rear	2240.0 lb
	Total	4090.0 lb
Tested Weight (Curb + 400 lb.)	Front	2446.0 lb
	Rear	2039.5 lb
	Total	4486.0 lb

Comments:

Recorded by: Dennis Grisez Date: 06/10/2004

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

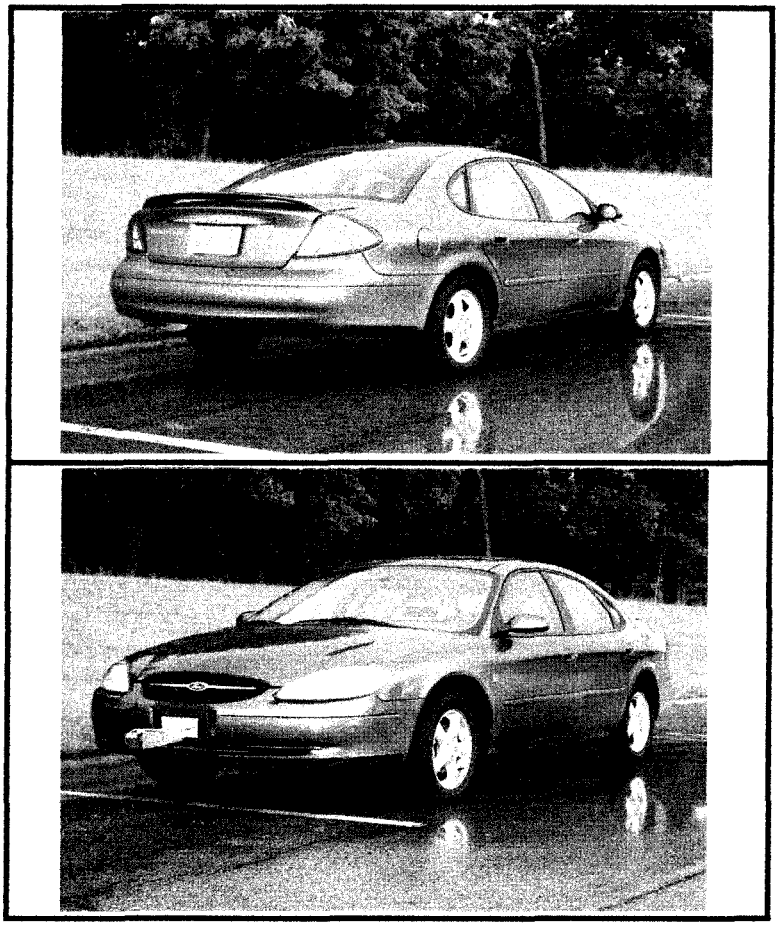
Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP5
VIN #	1FAFP55593A234364
Model Year	2003
Manufacturer	Ford Motor Company
Vehicle Model	Taurus SES
Body Style	4D Sedan
Wheelbase	108.5"
Mileage (SOT)	6391

Drivetrain	
Engine Type	V6
Displacement	3.0L
Transmission	Automatic 4 speed
Driven Axle(s)	FWD

Brake Package	
Front	Disk
Rear	Drum
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	6x16
Wheel Type	Alloy
Tire Make	Contentinnal
Tire Model	Touring Contact AS
Tire Size	P215/60 R16



Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.290"	30 Psi
Right Front	0.285"	30 Psi
Left Rear	0.310"	30 Psi
Right Rear	0.315"	30 Psi

Curb Weight	Front	*
	Rear	*
	Total	3310 lb
Tested Weight (Curb + 400 lb.)	Front	2346.5 lb
	Rear	1369.0 lb
	Total	3715.0 lb

Comments:

* Individual front and rear curb weights were not obtained.

Recorded by: Dennis Grisez Date: 06/25/2003

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

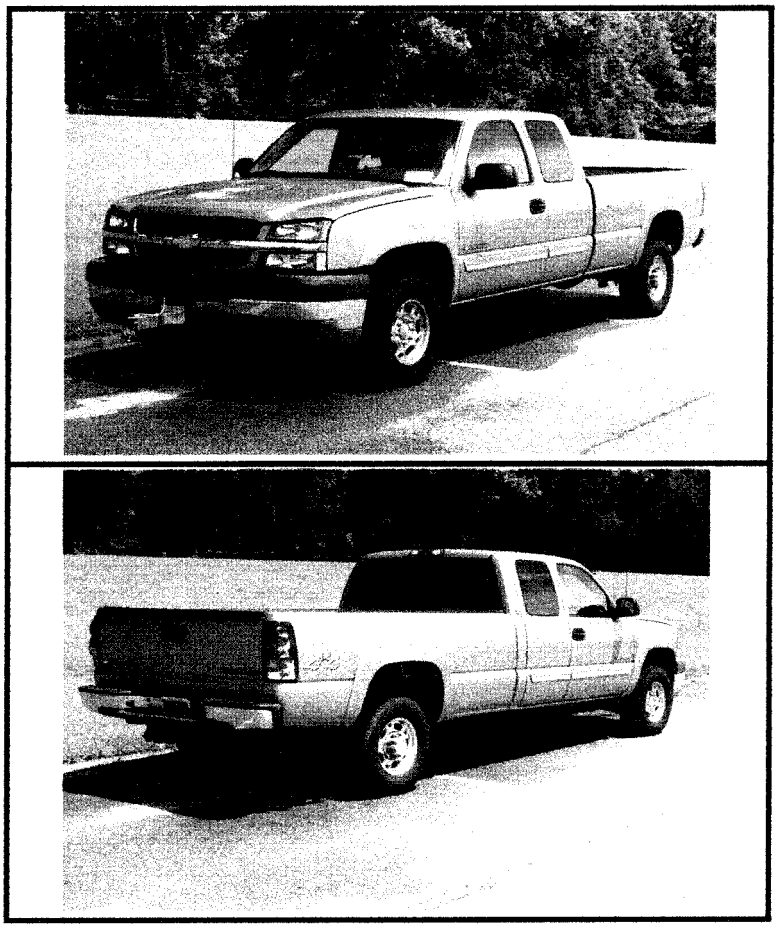
Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP6
VIN #	1GCHK29613E134988
Model Year	2003
Manufacturer	General Motors Co.
Vehicle Model	2500HD LS Silverado
Body Style	PU
Wheelbase	157.5"
Mileage (SOT)	18387

Drivetrain	
Engine Type	V8
Displacement	6.0L
Transmission	Automatic
Driven Axle(s)	4WD

Brake Package	
Front	Disk
Rear	Disk
4-Wheel ABS	Yes
Power Assist	Hydraulic Booster
Other	

Wheel and Tire	
Wheel Size	16x6.5J
Wheel Type	Alloy
Tire Make	Firestone
Tire Model	Steeltex Radial AT
Tire Size	LT 245/75 R16



Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.381	55 Psi
Right Front	0.390	55 Psi
Left Rear	0.323	80 Psi
Right Rear	0.280	80 Psi

Curb Weight	Front	3380.0 lb
	Rear	2490.0 lb
	Total	5870.0 lb
Tested Weight (Curb + 400 lb.)	Front	3687.0 lb
	Rear	2586.5 lb
	Total	6274.0 lb

Comments:

Recorded by: Dennis Grisez Date: 7/8/03

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

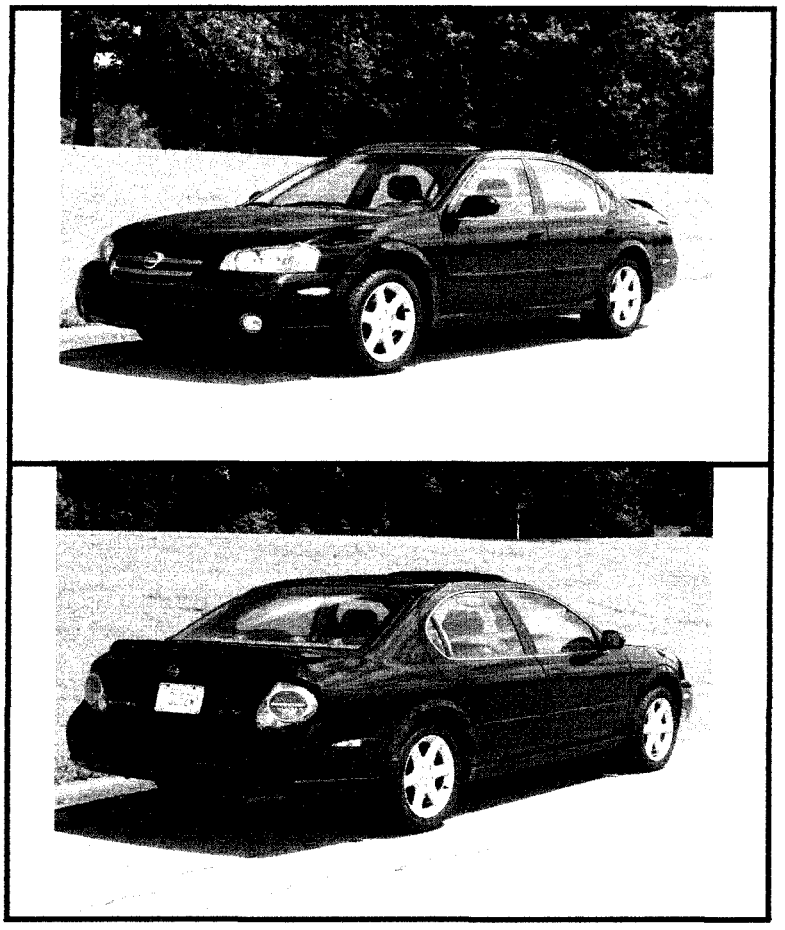
Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP7
VIN #	JN1DA31D62T429925
Model Year	2002
Manufacturer	Nissan Motor Co. LTD
Vehicle Model	Maxima SE
Body Style	4DR Sedan
Wheelbase	108.30"
Mileage (SOT)	7761

Drivetrain	
Engine Type	V6
Displacement	3.5L
Transmission	Automatic
Driven Axle(s)	FWD

Brake Package	
Front	Disk
Rear	Disk
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	17x7
Wheel Type	Alloy
Tire Make	Bridgestone
Tire Model	Potenza RE92
Tire Size	P225/50 R17



Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.285"	32 Psi
Right Front	0.245"	32 Psi
Left Rear	0.255"	32 Psi
Right Rear	0.295"	32 Psi

Curb Weight	Front	2040.0 lb
	Rear	1280 lb
	Total	3320 lb
Tested Weight (Curb + 400 lb.)	Front	2296.0 lb
	Rear	1426.0 lb
	Total	3722.0 lb

Comments:

Recorded by: Dennis Grisez Date: 07/11/2003

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

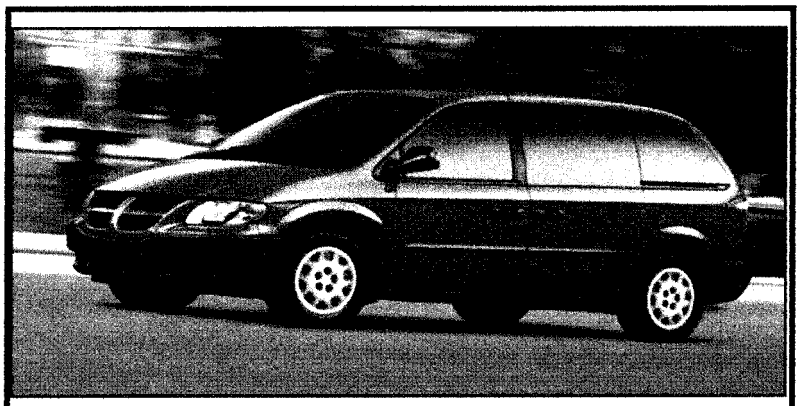
Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP8
VIN #	1046P24323B256422
Model Year	2003
Manufacturer	Daimler Chrysler
Vehicle Model	Caravan SE
Body Style	MPV
Wheelbase	113.3"
Mileage (SOT)	13761

Drivetrain	
Engine Type	V6
Displacement	3.3L
Transmission	Automatic 4 speed
Driven Axle(s)	FWD

Brake Package	
Front	Disk
Rear	Drum
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	15x6.5
Wheel Type	Steel wheels w/covers
Tire Make	Goodyear
Tire Model	Intregrity
Tire Size	215/70 R15



Note: not actual vehicle

Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.736"	36 Psi
Right Front	0.746"	36 Psi
Left Rear	0.731"	36 Psi
Right Rear	0.715"	36 Psi

Curb Weight	Front	2350.0 lb
	Rear	1740.0 lb
	Total	4090.0 lb
Tested Weight (Curb + 400 lb.)	Front	2622.0 lb.
	Rear	1870.5 lb
	Total	4492.5 lb

Comments:

Recorded by: Dennis Grisez Date: 07/02/2003

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

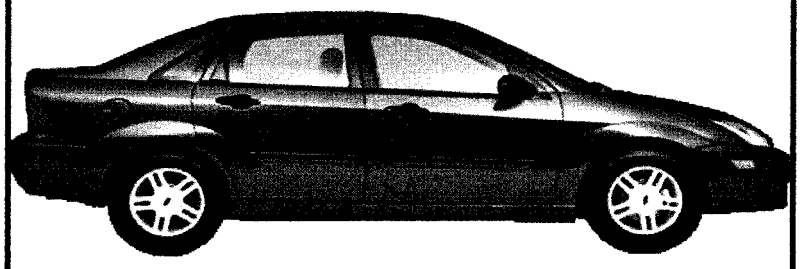
Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP9
VIN #	1FAFP34P63W257766
Model Year	2003
Manufacturer	Ford
Vehicle Model	Focus SE
Body Style	Sedan
Wheelbase	103.0"
Mileage (SOT)	10890

Drivetrain	
Engine Type	I4
Displacement	2.0 L
Transmission	Automatic
Driven Axle(s)	FWD

Brake Package	
Front	Disk
Rear	Drum
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	15x6.0"
Wheel Type	Alloy
Tire Make	Goodyear
Tire Model	Eagle RS-A
Tire Size	P195/60R15



Note: not actual vehicle

Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.284"	32 Psi
Right Front	0.275"	32 Psi
Left Rear	0.285"	32 Psi
Right Rear	0.297"	32 Psi

Curb Weight	Front	1650.0 lb
	Rear	1050.0 lb
	Total	2700.0 lb
Tested Weight (Curb + 400 lb.)	Front	1886.5 lb
	Rear	1216.0 lb
	Total	3102.5 lb

Comments:

Recorded by: Dennis Grisez Date: 08/06/2003

Vehicle Data Summary Sheet

NHTSA - Consumer Braking Information Program

Testing Conducted at Transportation Research Center, Inc.

General	
TRC Vehicle No:	NCAP10
VIN #	2FMZA52423BB34914
Model Year	2003
Manufacturer	Ford
Vehicle Model	Windstar SE
Body Style	MPV
Wheelbase	121.0"
Mileage (SOT)	9313

Drivetrain	
Engine Type	V6
Displacement	3.8 L
Transmission	Automatic
Driven Axle(s)	FWD

Brake Package	
Front	Disk
Rear	Drum
4-Wheel ABS	Yes
Power Assist	Yes
Other	

Wheel and Tire	
Wheel Size	
Wheel Type	Cast Aluminum
Tire Make	Michelin
Tire Model	Symetry All Season
Tire Size	P225/60R16

Tire Information	Avg. Tread Depth	Recommended Inflation Pressure
Left Front	0.275"	35 Psi
Right Front	0.277"	35 Psi
Left Rear	0.295"	35 Psi
Right Rear	0.306"	35 Psi

Curb Weight	Front	2500 lb
	Rear	1700 lb
	Total	4200 lb
Tested Weight (Curb + 400 lb.)	Front	2830 lb
	Rear	1770 lb
	Total	4600 lb

Comments:

Recorded by: Dennis Grisez Date: 08/19/2003

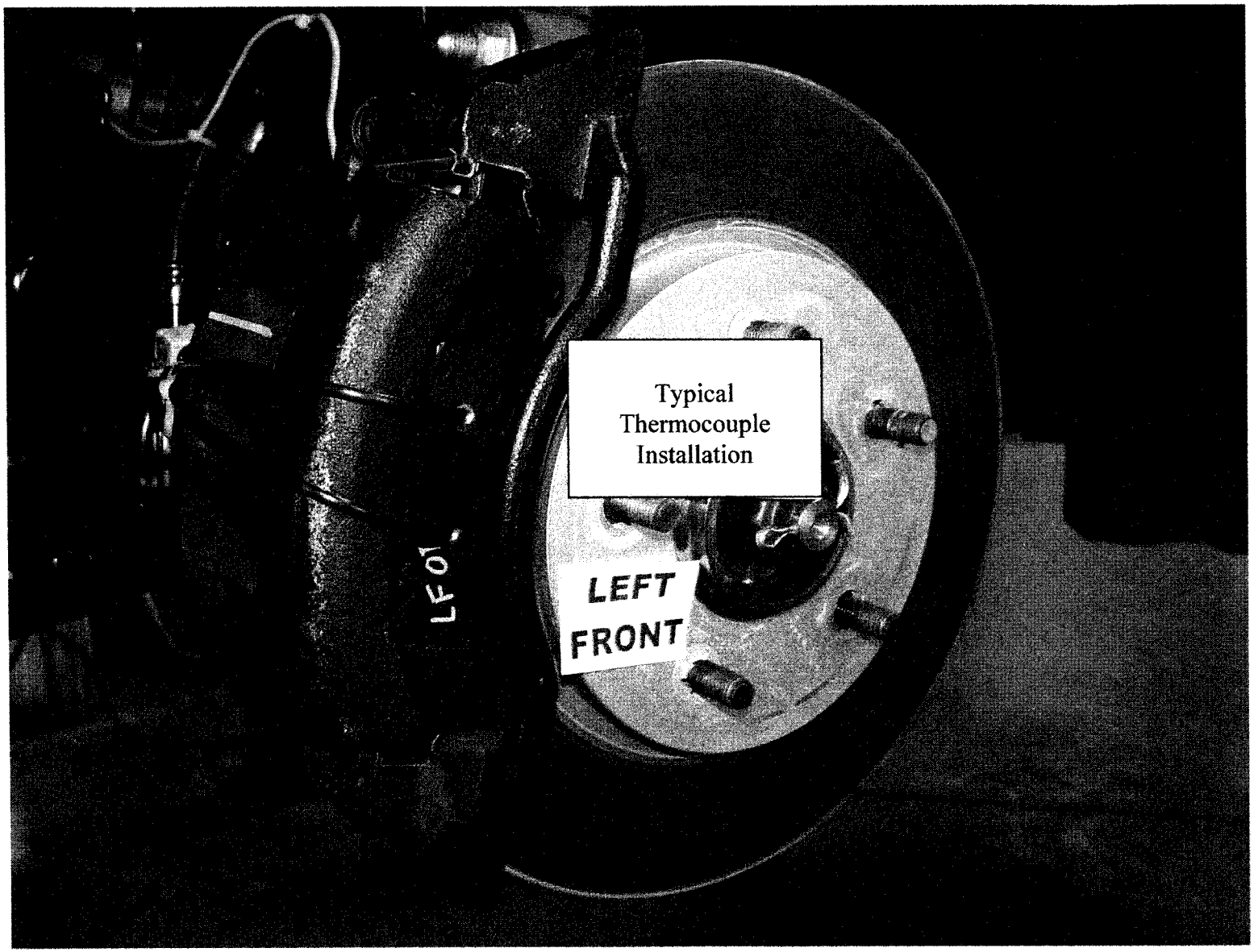
APPENDIX B

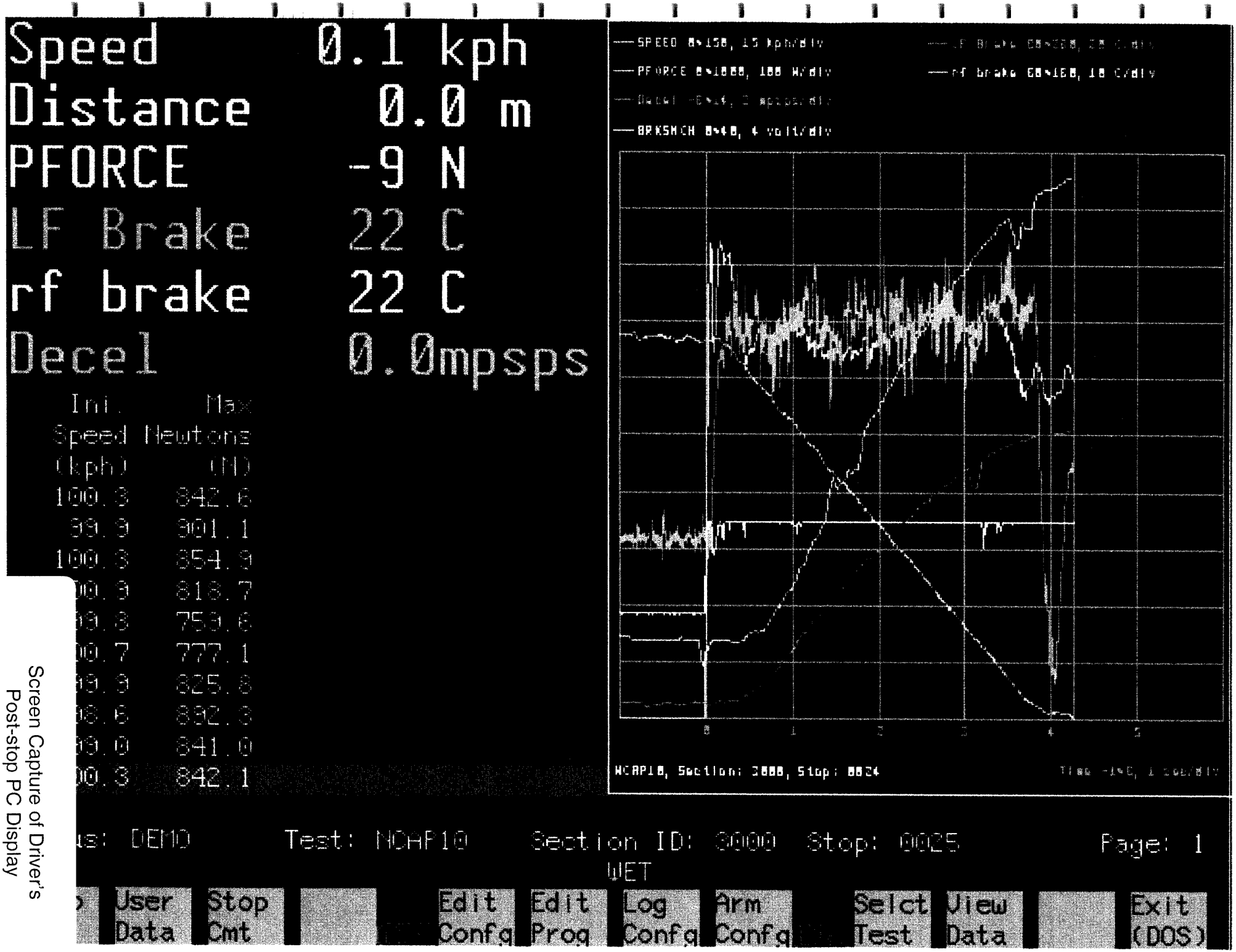
Test Instrumentation Data Sheets

Gage ID	Description	Gage S/N	Model No.	Type	Manufacturer	Last Calibrated By	Calibration Frequency	Calibration Frequency UOM	Last Cal Date
DAS-2050	Data acquistion system	955032	954031	LINK	Link Engineering	OSV	2	Years	20-Jan-03
A-791029	15g Accelerometer	791029	141A	Setra	Setra	Rick Waldeck	1	Years	09-Aug-02
5th-1400135	A_DAT Radar 5th wheels	1400135	DRS6 Radar	A_DAT	A-DAT	PickerM	1	Each Use	
LC-120	300# Pedal Force Transducer	42631	4351	GSE	Eaton	CALIBRATE BEFORE EACH USE	1	Each Use	

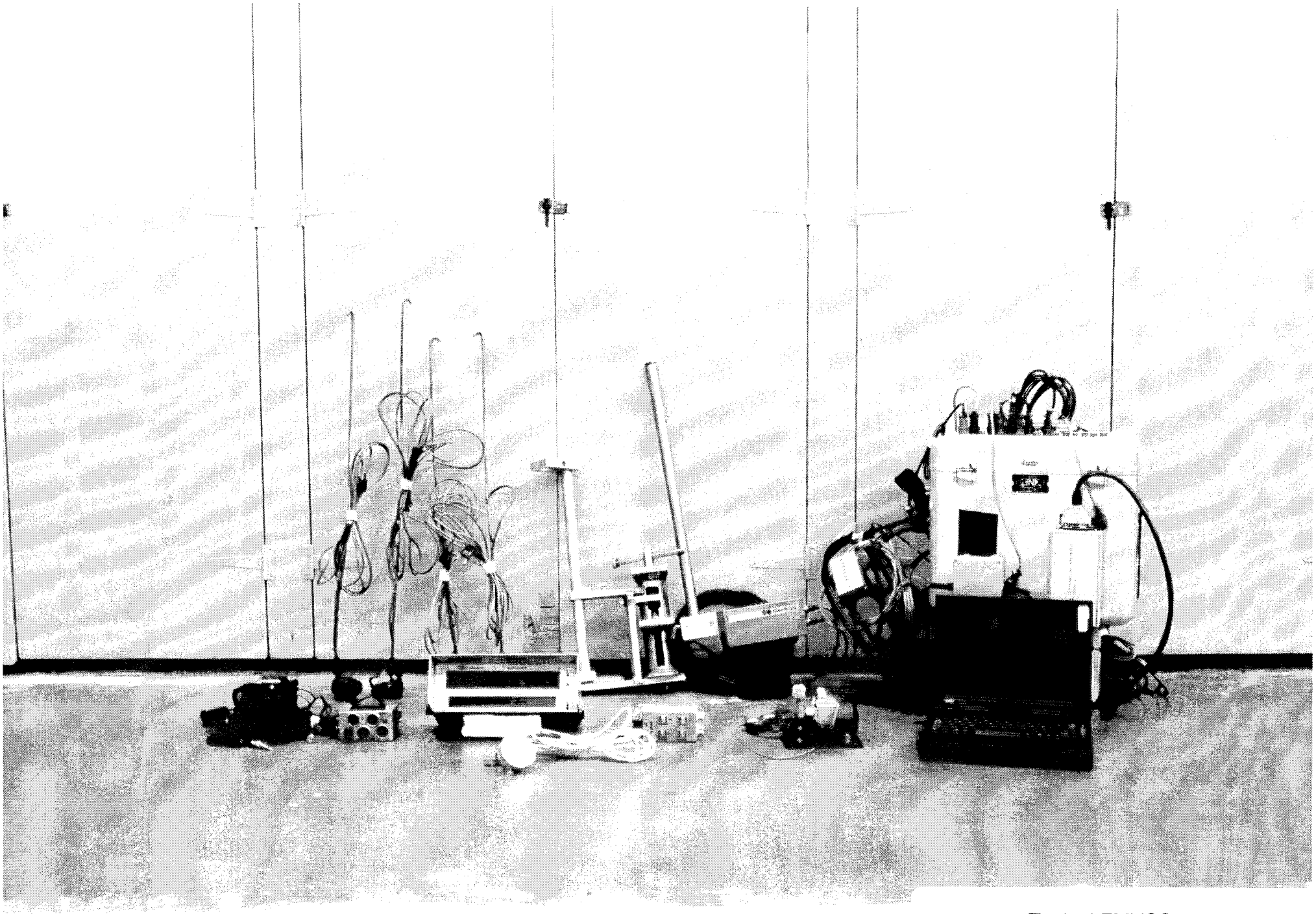
APPENDIX C

Test Instrumentation Photographs

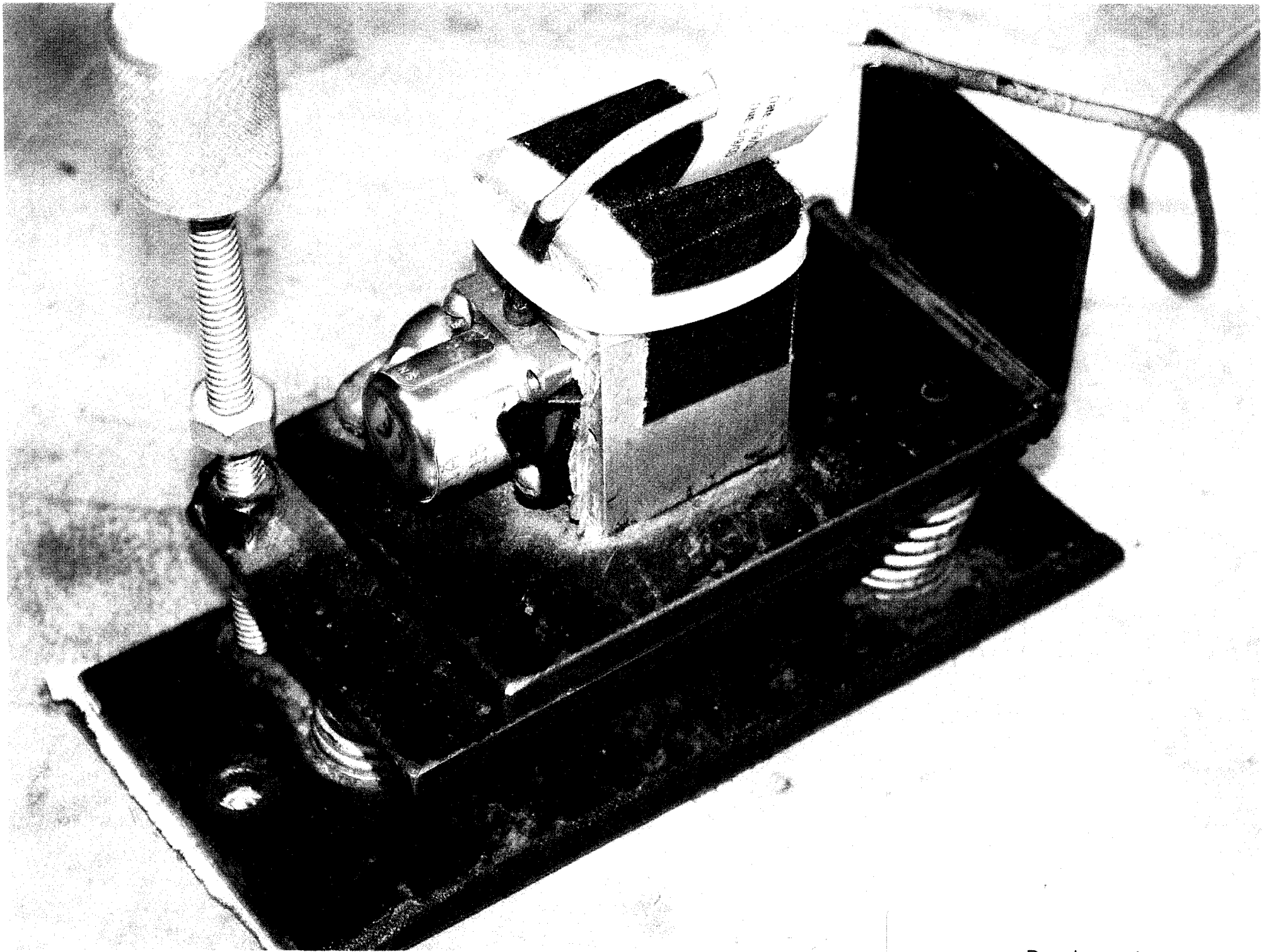

Typical
Thermocouple
Installation
LF01
LEFT
FRONT



Screen Capture of Driver's Post-stop PC Display



Typical FMVSS 135
Instrumentation Package

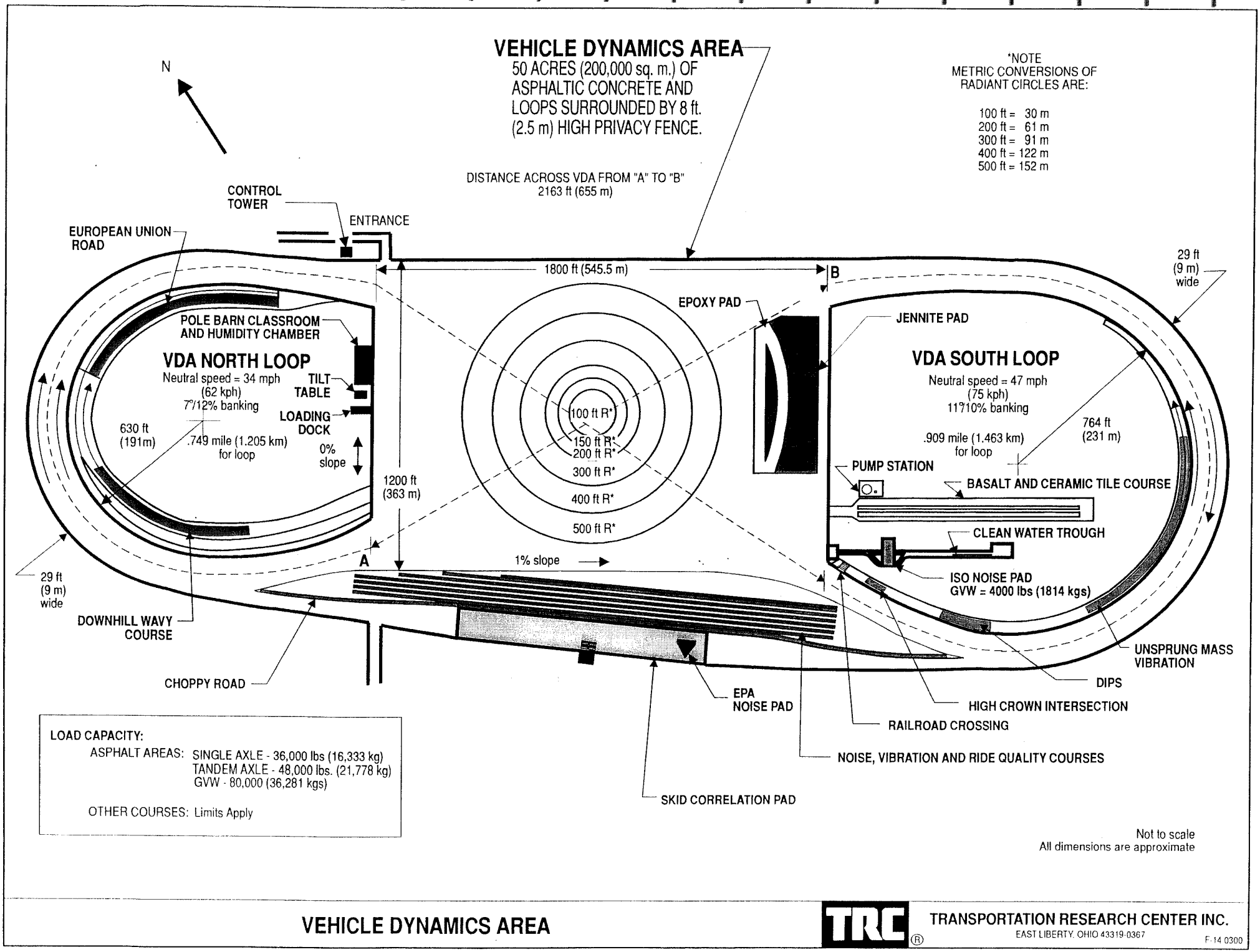


Decelerometer

Drum's Head-up Display

APPENDIX D

Test Site Information



VEHICLE DYNAMICS AREA

TRC®
TRANSPORTATION RESEARCH CENTER INC.
EAST LIBERTY, OHIO 43319-0367

APPENDIX E

Test Stop Data Sheets

Vehicle: 2002 HONDA
Make: ACCURA
Model: RSX
Body Style: 2-DOOR SEDAN
Front Cold Tire Pressure: 33 (psi)
Rear Cold Tire Pressure: 31 (psi)

NHTSA NUMBER: NCAP1

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 05/21/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:
INV DATA, Section 2000, 05/21/03, 10:26:43

Start Odo.: 0
End Odo.: 0

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	99.0	81.1	70.0	41.7	42.5	0.59	567.8	DRY
2	98.0	85.6	77.8	41.4	43.0	0.56	580.8	DRY
3	98.4	76.7	69.4	42.1	43.5	0.06	526.9	DRY
4	99.6	73.9	70.0	43.2	43.6	0.14	493.9	DRY
5	99.9	83.9	80.6	43.7	43.8	0.16	549.2	DRY
6	98.3	86.7	86.1	43.0	44.4	0.14	521.1	DRY
7	99.5	91.1	90.6	44.4	44.9	0.16	550.2	DRY
8	98.2	91.7	91.7	41.4	43.0	0.14	628.6	DRY
9	98.5	91.1	90.6	42.7	44.0	0.15	509.2	DRY
10	99.4	93.9	93.9	43.7	44.2	0.13	499.7	DRY
11	107.5	85.0	83.9	51.9	44.9	0.67	545.8	WET
12	98.9	88.9	88.3	43.6	44.5	0.47	619.2	WET
13	98.6	93.3	92.2	44.4	45.7	0.14	563.2	WET
14	99.5	91.7	92.8	45.4	45.9	0.12	641.8	WET
15	98.5	89.4	91.1	45.9	47.3	0.11	626.5	WET
16	97.9	91.1	91.1	45.3	47.2	0.16	495.0	WET
17	100.0	90.0	90.6	45.1	45.1	0.10	442.8	WET
18	100.4	93.3	93.9	44.7	44.4	0.13	441.3	WET
19	99.8	90.0	93.3	51.6	51.8	0.13	447.2	WET
20	99.7	92.2	93.3	43.7	44.0	1.13	467.2	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 05/30/03
Approving Laboratory Official: KEN WEBSTER Date: 06/03/03

Vehicle: 2003 GENERAL MOTORS NHTSA NUMBER: NCAP2
Make: PONTIAC
Model: BONNEVILLE
Body Style: 4-DOOR SEDAN
Front Cold Tire Pressure: 30 (psi)
Rear Cold Tire Pressure: 30 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 05/29/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:
INV DATA, Section 2000, 05/29/03, 11:55:49

Start Odo.: 0 End Odo.: 0

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	101.5	90.0	90.6	51.8	50.3	0.19	566.1	DRY
2	99.8	76.1	82.8	49.7	49.8	0.13	372.3	DRY
3	100.5	90.0	95.0	50.3	49.8	0.05	314.3	DRY
4	100.1	90.6	96.1	48.8	48.7	0.15	415.7	DRY
5	100.1	76.1	80.6	50.3	50.2	0.13	473.4	DRY
6	98.5	72.2	75.0	49.9	51.5	1.11	396.5	DRY
7	100.8	94.4	98.3	51.5	50.7	0.12	561.1	DRY
8	102.1	88.3	92.2	51.7	49.5	0.11	425.8	DRY
9	100.1	88.9	91.1	50.4	50.3	0.23	487.1	DRY
10	100.3	88.3	91.1	49.2	48.8	0.13	382.0	DRY
11	101.4	75.6	77.8	51.9	50.5	0.05	593.2	WET
12	99.7	90.0	95.6	51.7	52.0	0.04	399.4	WET
13	99.2	86.1	94.4	49.9	50.7	0.04	465.5	WET
14	101.0	85.6	95.0	51.5	50.5	0.15	493.7	WET
15	100.8	87.2	96.1	51.0	50.2	0.15	407.2	WET
16	100.1	86.7	93.9	52.0	52.0	0.08	356.8	WET
17	99.4	86.7	93.3	47.8	48.5	0.15	402.0	WET
18	99.1	87.8	93.9	49.5	50.4	0.05	415.6	WET
19	98.9	87.2	92.2	50.1	51.2	0.13	477.3	WET
20	99.7	85.0	87.8	51.4	51.7	0.20	500.1	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 06/05/03
Approving Laboratory Official: KEN WEBSTER Date: 06/07/03

Vehicle: 2001 GEN. MOTORS NHTSA NUMBER: NCAP3

Make: CHEVROLET

Model: TAHOE

Body Style: MPV

Front Cold Tire Pressure: 35 (psi)

Rear Cold Tire Pressure: 35 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 06/09/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:

INV DATA, Section 2000, 06/04/03, 13:15:24

Start Odo.: *E6***

End Odo.: *E6***

Schedule:

LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	100.2	75.6	76.1	62.1	61.9	0.06	487.8	WET
2	100.5	83.3	80.0	61.1	60.6	0.06	557.8	WET
3	101.3	87.8	86.1	59.0	57.4	0.05	678.5	WET
4	100.1	95.0	93.9	56.8	56.7	0.16	592.3	WET
5	99.4	91.7	87.2	58.7	59.4	0.17	580.3	WET
6	97.6	93.9	86.7	52.2	54.9	0.13	542.0	WET
7	99.3	94.4	87.8	58.3	59.2	0.05	603.8	WET
8	100.5	89.4	84.4	59.0	58.4	0.13	550.0	WET
9	99.9	92.2	83.9	59.6	59.7	0.05	415.9	WET
10	99.8	89.4	83.3	58.7	59.0	0.16	549.0	WET
11	99.6	78.9	80.0	59.8	60.2	0.04	407.5	DRY
12	98.9	84.4	87.2	58.3	59.6	0.04	381.5	DRY
13	98.8	84.4	87.2	57.8	59.2	0.77	496.3	DRY
14	100.2	88.9	89.4	56.3	56.1	0.17	527.4	DRY
15	99.2	80.0	78.3	56.9	57.8	0.16	461.4	DRY
16	100.0	86.1	85.6	55.6	55.6	0.06	510.5	DRY
17	99.4	91.1	90.0	55.0	55.6	0.15	499.6	DRY
18	99.8	91.7	88.3	55.0	55.2	0.16	506.7	DRY
19	99.4	87.2	82.8	57.2	57.9	0.08	481.4	DRY
20	98.7	85.6	83.9	53.5	55.0	0.15	526.9	DRY
32	101.1	93.3	96.1	57.2	56.0	0.02	610.3	DRY
33	99.6	91.1	93.9	56.5	56.9	0.06	510.4	DRY
34	100.9	92.8	94.4	59.7	58.6	0.02	424.2	DRY
35	100.3	92.8	92.8	58.0	57.7	0.02	491.6	DRY
36	100.7	95.0	92.8	57.7	56.9	0.03	461.6	DRY
37	100.5	93.3	92.2	57.5	56.9	0.02	452.5	DRY
38	99.5	95.0	94.4	57.6	58.2	0.05	480.0	DRY
39	100.8	96.1	90.0	56.7	55.8	0.04	538.2	DRY
40	99.2	95.0	87.8	59.8	60.8	0.75	502.8	DRY
41	99.0	98.9	92.8	55.6	56.7	0.02	579.2	DRY
42	98.7	92.2	98.9	61.6	63.3	0.64	580.7	WET
43	100.7	88.3	91.7	61.9	61.0	0.03	613.0	WET
44	99.0	86.7	88.9	59.8	61.0	0.02	511.4	WET
45	100.2	86.1	88.9	61.1	60.8	0.02	411.4	WET
46	100.9	87.8	91.1	60.3	59.2	0.02	459.8	WET
47	99.5	86.7	90.6	60.9	61.6	0.16	425.3	WET
48	99.6	87.8	91.7	59.3	59.8	0.03	524.8	WET
49	99.2	88.9	90.6	59.4	60.4	0.01	517.7	WET
50	99.7	88.3	92.8	60.1	60.4	0.01	545.6	WET
51	99.8	86.7	91.1	61.1	61.3	0.02	470.3	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: DAVE DULIN Observer: NONE

Recorded Data Processed by: CHUCK JENKINS Date: 06/09/03

Approving Laboratory Official: KEN WEBSTER Date: 06/09/03

Vehicle: 2003 DAIMLER CHRYSLR NHTSA NUMBER: NCAP4
Make: JEEP
Model: GRAND CHEROKEE
Body Style: MPV
Front Cold Tire Pressure: 35 (psi)
Rear Cold Tire Pressure: 35 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 06/09/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:
INV DATA, Section 2000, 06/11/03, 13:18:49

Start Odo.: *E6*** End Odo.: *E6***

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	98.2	78.3	79.4	51.1	53.0	0.89	432.4	WET
2	97.9	79.4	86.1	53.2	55.5	0.96	436.8	WET
3	99.4	77.2	85.6	52.9	53.5	0.70	488.2	WET
4	98.2	75.6	84.4	53.2	55.1	0.67	573.8	WET
5	99.4	74.4	84.4	52.9	53.6	0.03	479.7	WET
6	98.2	76.1	86.1	53.4	55.4	0.16	553.9	WET
7	100.0	72.2	81.1	54.6	54.6	0.60	491.9	WET
8	100.0	76.7	86.1	53.2	53.1	0.02	503.0	WET
9	98.6	76.7	86.7	53.5	55.1	0.03	460.9	WET
10	98.9	75.6	85.0	51.5	52.7	0.16	550.1	WET
11	99.4	77.2	80.6	46.6	47.1	2.12	458.9	DRY
12	98.9	82.8	85.6	46.8	47.8	0.90	393.5	DRY
13	100.5	76.7	81.1	46.2	45.7	0.06	451.5	DRY
14	98.7	81.7	85.0	46.0	47.3	0.06	532.6	DRY
15	99.5	70.0	76.7	46.9	47.4	0.15	477.2	DRY
16	98.8	72.2	77.8	45.8	47.0	0.06	460.3	DRY
17	99.7	70.6	76.7	48.3	48.6	0.04	488.7	DRY
18	99.6	75.0	80.0	47.5	47.8	0.05	497.8	DRY
19	98.6	72.8	76.7	47.7	49.1	0.02	505.6	DRY
20	98.5	71.1	74.4	47.3	48.8	0.05	512.6	DRY

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: DAVID DULIN Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 06/11/03
Approving Laboratory Official: KEN WEBSTER Date: 06/11/03

Vehicle: 2003 FORD
Make: TAURUS
Model: SES
Body Style: 4 DOOR
Front Cold Tire Pressure: 30 (psi)
Rear Cold Tire Pressure: 30 (psi)

NHTSA NUMBER: NCAP5

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 06/30/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:
INV DATA, Section 2000, 06/30/03, 11:47:45

Start Odo.: *E6***
End Odo.: *E6***

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	99.8	71.7	77.2	51.1	51.3	0.15	426.1	DRY
2	100.0	86.7	95.0	51.4	51.4	0.14	539.3	DRY
3	100.0	83.9	87.8	51.8	51.8	0.16	523.0	DRY
4	101.6	83.3	88.9	54.0	52.3	0.16	415.2	DRY
5	100.0	87.8	90.0	51.6	51.7	0.72	504.0	DRY
6	99.6	68.3	74.4	51.2	51.6	1.05	299.5	DRY
7	99.9	65.0	74.4	51.6	51.6	0.14	595.9	DRY
8	100.6	78.9	85.0	51.4	50.7	0.15	526.7	DRY
9	99.3	82.8	90.6	51.7	52.4	0.14	540.1	DRY
10	98.9	84.4	92.2	51.3	52.5	0.15	462.6	DRY
11	99.7	81.7	88.9	51.7	52.0	1.65	400.3	DRY
12	99.9	85.0	89.4	50.5	50.6	0.65	479.2	DRY
13	99.7	86.1	90.0	52.5	52.8	0.53	600.7	DRY
14	99.5	85.6	88.9	50.0	50.4	0.66	540.7	DRY
15	100.5	76.7	84.4	50.4	49.9	0.51	501.2	DRY
16	100.3	78.9	86.1	50.7	50.4	0.18	503.8	DRY
17	99.8	81.1	83.3	49.6	49.8	0.03	469.8	DRY
18	100.6	82.8	87.8	51.6	51.0	0.04	564.8	DRY
19	99.7	79.4	83.9	51.5	51.8	0.54	513.0	DRY
20	100.5	83.3	87.2	51.3	50.8	0.04	470.6	DRY
21	99.1	96.1	98.3	59.6	60.6	0.05	526.2	WET
22	99.8	92.2	96.1	58.9	59.1	0.04	379.4	WET
23	99.6	92.2	94.4	58.7	59.1	0.05	441.4	WET
24	98.8	92.2	94.4	59.1	60.5	0.16	455.5	WET
25	98.3	91.7	92.8	56.7	58.6	0.61	536.2	WET
26	98.7	92.8	92.2	58.6	60.1	0.70	505.3	WET
27	98.7	91.7	92.2	59.1	60.6	0.04	557.4	WET
28	98.9	90.0	93.3	57.5	58.8	0.04	501.0	WET
29	99.4	87.8	92.8	57.7	58.5	0.03	535.0	WET
30	100.8	83.9	91.1	59.0	58.0	0.04	473.9	WET
31	101.0	74.4	72.2	57.2	56.1	0.04	522.3	WET
32	99.4	91.7	89.4	57.3	58.0	0.05	458.1	WET
33	100.2	91.1	92.8	57.9	57.7	0.08	407.4	WET
34	99.0	86.1	92.2	54.4	55.5	0.05	475.5	WET
35	99.5	84.4	92.8	57.4	58.0	0.06	501.0	WET
36	97.7	75.0	75.0	54.7	57.3	0.14	452.3	WET
37	98.3	90.0	92.2	56.7	58.7	0.07	441.7	WET
38	98.8	84.4	90.0	55.2	56.5	0.08	580.2	WET
39	100.2	90.0	93.9	59.0	58.8	0.12	510.2	WET
40	99.6	87.2	92.8	57.3	57.8	0.06	516.1	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS.(X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 07/07/03
Approving Laboratory Official: KEN WEBSTER Date: 07/10/03

Vehicle: 2003 FORD
Make: TAURUS
Model: SES
Body Style: 4 DOOR
Front Cold Tire Pressure: 30 (psi)
Rear Cold Tire Pressure: 30 (psi)

NHTSA NUMBER: NCAP5

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 06/30/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 670 NEWTONS

Testing Conditions:
INV DATA, Section 3000, 06/30/03, 14:16:08

Start Odo.: *E6***
End Odo.: *E6***

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	100.6	76.1	82.2	52.7	52.1	0.05	606.1	DRY
2	101.4	85.0	92.8	53.6	52.2	0.12	626.8	
3	99.9	83.3	90.6	50.7	50.8	0.15	696.4	DRY
4	100.4	85.0	90.0	52.3	51.9	0.14	602.6	DRY
5	100.7	85.0	88.9	53.1	52.3	0.05	741.8	
6	99.9	80.6	83.9	52.8	52.9	0.08	748.9	DRY
7	99.2	86.7	88.3	50.9	51.7	0.12	764.4	DRY
8	100.0	83.3	84.4	52.5	52.5	0.04	715.7	
9	99.7	90.0	90.0	51.0	51.3	0.05	634.9	DRY
10	99.8	87.8	88.3	52.2	52.4	0.07	667.5	DRY
11	100.2	91.1	93.9	50.8	50.6	0.13	710.4	DRY
12	100.5	88.3	93.3	50.1	49.6	0.05	808.0	DRY
13	99.6	73.3	81.1	52.0	52.4	0.20	671.8	DRY
14	99.9	83.3	90.0	50.6	50.7	0.06	642.3	DRY
15	100.5	84.4	88.9	52.1	51.6	0.05	729.3	DRY
16	99.5	93.3	96.1	49.8	50.3	0.04	696.7	DRY
17	100.5	79.4	84.4	51.8	51.3	0.03	709.9	DRY
18	99.3	84.4	90.0	49.5	50.2	0.06	639.9	DRY
19	99.9	80.6	90.0	51.2	51.3	0.05	666.7	DRY
20	100.0	86.1	93.3	51.1	51.1	0.12	659.0	DRY
21	99.6	81.1	87.8	58.3	58.7	0.31	661.3	WET
22	100.4	85.0	88.9	56.5	56.1	0.02	778.3	WET
23	99.4	92.2	92.8	55.8	56.4	0.02	695.6	WET
24	100.1	95.0	95.6	57.3	57.2	0.02	596.5	WET
25	99.7	93.9	95.0	58.2	58.5	0.06	659.3	WET
26	100.5	90.6	88.9	55.6	55.1	0.25	760.2	WET
27	98.7	93.9	89.4	57.1	58.5	0.02	683.0	WET
28	99.1	93.3	91.7	54.8	55.7	0.02	661.7	WET
29	99.4	96.1	87.8	54.7	55.3	0.03	644.6	WET
30	100.3	92.2	88.3	55.3	55.0	0.03	643.7	WET
31	99.4	85.6	92.2	59.2	60.0	0.06	642.4	WET
32	99.1	85.0	93.3	58.0	59.1	0.05	603.5	WET
33	99.9	84.4	92.2	55.2	55.3	0.05	707.7	WET
34	100.8	86.1	92.2	59.0	58.0	0.07	715.0	WET
35	99.6	85.6	93.3	55.6	56.0	0.05	699.3	WET
36	100.4	84.4	92.2	55.1	54.7	0.14	696.1	WET
37	100.5	82.8	91.7	56.1	55.5	0.12	715.4	WET
38	99.6	86.1	93.9	60.2	60.6	0.07	799.4	WET
39	99.5	83.3	92.8	57.7	58.3	0.05	688.4	WET
40	100.0	85.6	95.0	59.3	59.3	0.04	775.1	

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 07/07/03
Approving Laboratory Official: KEN WEBSTER Date: 07/10/03

Vehicle: 2003 GEN. MOTORS NHTSA NUMBER: NCAP6

Make: CHEVROLET

Model: SILVERADO2500HD

Body Style: PICK-UP

Front Cold Tire Pressure: 55 (psi)

Rear Cold Tire Pressure: 80 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 07/10/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:

INV DATA, Section 2000, 07/10/03, 09:46:34

Start Odo.: *E6*** End Odo.: *E6***

Schedule: Performance Requirements: None

LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	100.5	67.8	66.7	60.9	60.2	0.05	63.7	WET
2	100.0	79.4	78.3	60.3	60.2	0.09	573.0	WET
3	100.8	96.1	93.9	60.8	59.8	0.07	595.6	WET
4	98.3	89.4	88.3	60.1	62.1	0.13	641.0	WET
5	99.2	90.6	87.8	61.2	62.2	0.24	669.1	WET
6	100.0	92.2	91.1	59.6	59.6	0.17	622.2	WET
7	99.2	89.4	87.8	60.6	61.6	0.09	566.0	WET
8	99.2	91.1	91.1	58.3	59.3	0.24	516.6	WET
9	99.2	70.0	68.3	59.4	60.4	0.09	438.1	WET
10	101.1	87.8	86.1	60.1	58.8	0.23	645.3	WET
11	99.6	72.8	72.2	52.8	53.2	0.08	516.7	DRY
12	99.8	94.4	97.8	53.5	53.7	0.07	430.7	DRY
13	101.4	71.1	78.9	52.5	51.0	0.07	496.5	DRY
14	100.8	85.6	90.6	52.9	52.1	0.07	450.5	DRY
15	99.2	88.9	93.9	52.8	53.7	1.10	440.0	DRY
16	99.2	85.0	91.7	53.5	54.3	0.06	437.6	DRY
17	99.2	78.9	85.0	52.3	53.2	0.22	536.3	DRY
18	98.7	84.4	90.6	52.1	53.5	0.17	468.1	DRY
19	100.7	88.9	95.0	52.8	52.1	0.19	491.2	DRY
20	99.0	87.8	93.9	52.3	53.3	0.06	567.4	DRY

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE

Recorded Data Processed by: CHUCK JENKINS Date: 07/15/03

Approving Laboratory Official: KEN WEBSTER Date: 07/20/03

Vehicle: 2003 GEN. MOTORS NHTSA NUMBER: NCAP6

Make: CHEVROLET

Model: SILVERADO2500HD

Body Style: PICK-UP

Front Cold Tire Pressure: 55 (psi)

Rear Cold Tire Pressure: 80 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 07/10/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 670 NEWTONS

Testing Conditions:

INV DATA, Section 3000, 07/10/03, 11:44:38

Start Odo.: 18387

End Odo.: 18445

Schedule:

Performance Requirements: None

LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	98.8	71.7	72.8	58.5	59.9	0.07	439.1	WET
2	99.0	77.8	76.1	66.6	68.0	0.21	568.3	WET
3	99.9	92.8	96.1	62.4	62.5	0.16	733.7	WET
4	100.2	92.2	96.1	60.9	60.6	0.05	675.1	WET
5	100.7	91.7	95.0	62.3	61.3	0.04	698.6	WET
6	99.4	91.1	94.4	63.3	64.0	0.06	758.3	
7	99.1	93.3	93.3	60.5	61.7	0.06	630.5	WET
8	98.5	76.7	77.2	62.7	64.6	0.06	677.5	WET
9	98.6	93.3	90.0	61.4	63.2	0.03	594.7	WET
10	101.0	91.7	90.0	63.1	61.9	0.04	704.9	WET
11	100.1	75.6	80.6	50.5	50.4	1.11	350.5	DRY
12	99.9	91.7	97.2	51.8	51.9	0.04	556.1	DRY
13	99.0	84.4	88.3	52.3	53.4	0.05	525.9	DRY
14	100.0	75.0	79.4	51.8	51.8	0.07	609.4	DRY
15	100.0	87.2	91.1	51.6	51.6	0.15	752.3	DRY
16	99.5	87.8	92.8	51.1	51.5	0.08	646.9	DRY
17	99.6	90.6	96.7	52.8	53.2	0.16	690.7	DRY
18	98.9	90.0	96.1	51.4	52.5	0.07	618.5	DRY
19	101.1	86.1	92.2	53.4	52.2	0.23	680.9	DRY
20	99.2	87.8	95.0	53.7	54.5	0.04	682.9	

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE

Recorded Data Processed by: CHUCK JENKINS Date: 07/15/03

Approving Laboratory Official: KEN WEBSTER Date: 07/20/03

Vehicle: 2002 NISSAN MOT.CO. NHTSA NUMBER: NCAP7
Make: NISSAN
Model: MAXIMA SE
Body Style: SEDAN
Front Cold Tire Pressure: 32 (psi)
Rear Cold Tire Pressure: 32 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 07/16/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:
INV DATA, Section 2000, 07/16/03, 10:04:20

Start Odo.: *E6***
End Odo.: *E6***

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	98.9	60.6	71.7	45.8	46.8	1.05	459.5	DRY
2	98.4	73.9	83.3	47.2	48.7	0.10	580.6	DRY
3	98.6	75.6	84.4	45.9	47.2	0.69	512.5	DRY
4	101.1	71.7	80.6	47.9	46.9	0.09	569.0	DRY
5	98.4	79.4	86.7	46.4	47.9	0.13	536.0	DRY
6	101.9	80.0	86.7	48.7	47.0	0.10	647.3	DRY
7	99.9	73.9	78.3	46.9	47.0	0.57	600.9	DRY
8	100.0	76.1	85.0	47.4	47.4	0.16	541.5	DRY
9	98.8	71.7	80.6	46.8	48.0	0.16	480.6	DRY
10	100.4	68.9	79.4	47.5	47.1	0.47	540.5	DRY
11	99.7	67.2	70.0	51.1	51.4	0.48	610.2	WET
12	100.4	75.6	83.9	48.6	48.2	0.14	619.8	WET
13	98.9	78.9	86.1	49.2	50.3	0.07	519.3	WET
14	99.5	75.0	83.9	48.9	49.4	0.10	554.1	WET
15	99.2	73.3	84.4	50.4	51.2	0.42	498.1	WET
16	100.5	73.3	82.2	49.1	48.6	0.16	584.5	WET
17	99.9	75.0	85.6	49.8	49.9	0.12	483.4	WET
18	101.7	77.8	86.1	51.3	49.6	0.14	541.8	WET
19	97.6	74.4	82.8	47.7	50.0	0.44	547.0	WET
20	99.6	78.9	86.1	49.3	49.7	0.11	511.9	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 07/18/03
Approving Laboratory Official: KEN WEBSTER Date: 07/25/03

Vehicle: 2002 NISSAN MOT.CO. NHTSA NUMBER: NCAP7
Make: NISSAN
Model: MAXIMA SE
Body Style: SEDAN
Front Cold Tire Pressure: 32 (psi)
Rear Cold Tire Pressure: 32 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 07/16/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 670 NEWTONS

Testing Conditions:
INV DATA, Section 3000, 07/16/03, 11:00:24

Start Odo.: 7789 End Odo.: 7834

Schedule: Performance Requirements: None

LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	99.9	80.0	87.8	45.6	45.7	0.17	699.6	DRY
2	99.7	75.6	83.3	47.1	47.3	0.20	737.6	DRY
3	99.8	70.6	76.7	45.9	46.0	0.13	657.3	DRY
4	98.6	72.8	77.2	45.6	46.9	0.09	650.7	DRY
5	98.5	73.3	80.0	45.4	46.7	0.14	681.9	DRY
6	99.0	74.4	82.8	44.6	45.5	0.18	581.6	DRY
7	100.5	76.7	83.3	47.7	47.2	0.12	689.6	DRY
8	101.1	67.2	73.9	46.4	45.4	0.12	643.6	DRY
9	99.3	78.9	83.3	45.2	45.9	0.09	663.9	DRY
10	98.6	67.2	71.7	44.0	45.3	0.17	646.0	DRY
11	98.5	67.2	79.4	49.8	51.3	0.10	678.8	WET
12	100.0	72.2	82.8	51.0	51.0	0.40	701.5	WET
13	99.3	75.6	82.8	49.0	49.7	0.13	577.6	WET
14	100.0	63.9	75.6	48.7	48.7	0.13	678.5	WET
15	99.4	71.7	81.7	48.8	49.4	0.13	644.7	WET
16	98.2	73.9	83.3	46.6	48.4	0.10	723.6	WET
17	101.8	78.3	88.9	50.4	48.7	0.14	757.3	WET
18	99.4	78.3	86.1	49.6	50.2	0.06	598.5	WET
19	98.7	78.3	87.2	49.8	51.1	0.11	732.2	WET
20	101.3	83.3	92.2	50.5	49.2	0.06	690.6	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 07/18/03
Approving Laboratory Official: KEN WEBSTER Date: 07/25/03

Vehicle: 2003 DAIMLER CHRYSLR NHTSA NUMBER: NCAP8
Make: DODGE
Model: GRAND CARAVANSE
Body Style: MPV
Front Cold Tire Pressure: 36 (psi)
Rear Cold Tire Pressure: 36 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 07/23/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:
INV DATA, Section 2000, 07/23/03, 09:44:04

Start Odo.: *E6***
End Odo.: *E6***

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	98.7	93.3	87.8	50.6	52.0	0.13	640.7	DRY
2	99.9	87.2	89.4	49.0	49.1	0.06	544.7	DRY
3	100.5	92.8	92.8	49.7	49.1	0.05	600.4	DRY
4	98.4	90.0	89.4	46.8	48.3	0.11	562.5	DRY
5	99.9	91.1	90.6	46.1	46.2	0.10	454.9	DRY
6	100.8	94.4	87.8	48.5	47.8	0.10	466.7	DRY
7	99.5	89.4	87.8	47.5	48.0	0.08	377.5	DRY
8	99.7	90.6	90.6	46.1	46.4	0.10	421.6	DRY
9	101.0	85.0	81.7	47.7	46.7	0.09	381.0	DRY
10	98.5	91.7	87.2	45.4	46.8	0.11	463.8	DRY
11	99.2	87.8	85.0	55.7	56.6	0.05	695.9	WET
12	99.6	89.4	91.1	54.9	55.3	0.09	458.1	WET
13	99.7	91.7	90.6	54.8	55.2	0.05	575.0	WET
14	99.9	89.4	93.3	55.0	55.2	0.16	500.5	WET
15	100.4	91.1	96.7	55.1	54.6	0.22	448.8	WET
16	99.6	91.7	91.1	55.0	55.5	0.13	511.2	WET
17	101.3	86.7	84.4	57.2	55.7	0.18	502.9	WET
18	100.2	87.2	89.4	52.4	52.2	0.05	450.4	WET
19	99.7	86.1	88.9	56.2	56.5	0.14	415.3	WET
20	100.4	91.1	92.2	53.9	53.5	0.17	442.6	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIRREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 7/24/03
Approving Laboratory Official: KEN WEBSTER Date: 7/31/03

Vehicle: 2003 DAIMLER CHRYSLR NHTSA NUMBER: NCAP8
Make: DODGE
Model: GRAND CARAVANSE
Body Style: MPV
Front Cold Tire Pressure: 36 (psi)
Rear Cold Tire Pressure: 36 (psi)

Transportation Research Center, Inc.
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East Liberty, Ohio 43319
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Date Tested: 07/23/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 670 NEWTONS

Testing Conditions:
INV DATA, Section 3000, 07/23/03, 11:41:51

Start Odo.: 13779
End Odo.: 13832

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	99.8	92.8	86.1	47.0	47.2	0.10	602.2	DRY
2	99.9	97.2	88.3	47.6	47.8	0.11	574.9	DRY
3	101.5	96.1	91.7	49.9	48.4	0.13	650.9	DRY
4	100.4	91.1	87.2	46.4	46.0	0.16	638.8	DRY
5	100.1	90.0	84.4	48.9	48.8	0.13	770.4	DRY
6	100.2	97.8	92.8	47.3	47.2	0.05	559.7	DRY
7	101.1	68.3	68.9	49.0	47.9	0.12	648.7	DRY
8	99.9	89.4	92.2	47.0	47.1	0.15	632.0	DRY
9	100.5	90.6	90.6	45.4	45.0	0.05	528.5	DRY
10	100.1	93.9	94.4	46.8	46.7	0.11	574.0	DRY
11	99.7	71.7	67.8	56.0	56.3	0.14	649.8	WET
12	98.7	95.0	92.8	55.4	56.9	0.16	742.4	WET
13	102.1	93.9	92.2	56.5	54.2	0.12	665.6	WET
14	99.3	87.2	91.7	54.2	54.9	0.12	583.3	WET
15	99.8	90.0	90.6	53.6	53.8	0.12	713.1	WET
16	96.7	91.1	91.7	49.9	53.4	0.09	610.5	WET
17	101.6	87.8	1371.1	55.6	53.8	0.04	744.6	WET
18	98.6	94.4	90.6	52.0	53.5	0.14	632.5	WET
19	100.8	89.4	81.1	53.9	53.1	0.16	658.8	WET
20	99.4	93.9	86.7	54.5	55.2	0.10	645.1	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: KAREN EASTERDAY Observer: NONE
Recorded Data Processed by: CHUCK JENKINS Date: 7/24/03
Approving Laboratory Official: KEN WEBSTER Date: 7/31/03

Vehicle: 2003 FORD MOTOR CO NHTSA NUMBER: NCAP9

Make: FORD

Model: FOCUS SE

Body Style: SEDAN 4 DOOR

Front Cold Tire Pressure: 32 (psi)

Rear Cold Tire Pressure: 32 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 08/11/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:

INV DATA, Section 2000, 08/11/03, 10:26:42

Start Odo.: 10902

End Odo.: 10962

Schedule:

Performance Requirements: None

LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	99.3	85.0	83.9	46.7	47.4	0.15	537.5	DRY
2	100.9	88.9	89.4	49.1	48.3	0.04	571.4	DRY
3	98.2	92.2	93.9	46.8	48.5	0.15	572.1	DRY
4	99.4	82.2	95.6	46.2	46.7	0.02	481.8	DRY
5	99.2	82.2	89.4	47.3	48.1	0.13	467.8	DRY
6	99.7	86.1	96.7	46.2	46.5	0.03	462.0	DRY
7	99.3	85.0	93.9	45.6	46.3	0.04	534.8	DRY
8	98.9	83.3	97.2	47.2	48.3	0.04	500.5	DRY
9	99.1	83.9	97.2	46.0	46.8	0.03	553.7	DRY
10	99.3	86.1	98.3	47.6	48.3	0.03	536.2	DRY
11	99.9	71.7	83.3	53.5	53.6	0.00	367.4	WET
12	99.0	79.4	84.4	49.1	50.0	0.16	483.5	WET
13	98.0	73.9	81.1	52.1	54.3	0.04	475.1	WET
14	100.1	84.4	90.0	50.3	50.2	0.03	564.4	WET
15	99.2	79.4	86.1	51.9	52.8	0.30	577.0	WET
16	99.9	78.3	95.0	50.6	50.7	0.03	550.1	WET
17	99.6	78.9	95.0	51.4	51.8	0.04	528.3	WET
18	99.4	77.2	94.4	50.0	50.6	0.02	507.1	WET
19	98.9	78.3	92.2	49.9	51.1	0.04	495.4	WET
20	99.2	75.6	90.6	49.8	50.6	0.03	520.9	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: DAVID DULIN Observer: NONE

Recorded Data Processed by: CHUCK JENKINS Date:

Approving Laboratory Official: KEN WEBSTER Date:

Vehicle: 2003 FORD MOTOR CO NHTSA NUMBER: NCAP9

Make: FORD

Model: FOCUS SE

Body Style: SEDAN 4 DOOR

Front Cold Tire Pressure: 32 (psi)

Rear Cold Tire Pressure: 32 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 08/11/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 670 NEWTONS

Testing Conditions:

INV DATA, Section 3000, 08/11/03, 11:39:01

Start Odo.: 10902

End Odo.: 10962

Schedule:

Performance Requirements: None

LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	100.0	85.0	96.7	46.2	46.2	0.02	715.5	DRY
2	100.4	83.9	96.7	45.9	45.5	0.02	739.6	DRY
3	99.6	84.4	96.7	46.4	46.8	0.02	734.3	DRY
4	100.8	85.6	97.8	45.6	44.9	0.02	720.1	DRY
5	100.2	87.2	96.1	44.6	44.4	0.02	821.8	DRY
6	99.7	85.6	93.3	46.2	46.5	0.02	673.1	DRY
7	99.5	86.1	91.7	45.9	46.3	0.04	739.4	DRY
8	100.1	87.8	95.0	44.7	44.6	0.02	690.7	DRY
9	100.2	86.7	94.4	45.9	45.6	0.03	754.2	DRY
10	100.3	87.8	95.6	44.6	44.3	0.03	727.0	DRY
11	99.7	76.1	85.0	48.3	48.6	0.01	661.3	WET
12	99.4	81.7	92.8	51.9	52.5	0.03	603.9	WET
13	99.9	85.6	96.1	48.3	48.5	0.01	783.7	WET
14	99.7	82.8	96.7	50.5	50.8	0.01	714.7	WET
15	99.1	85.6	95.6	49.2	50.1	0.01	672.7	WET
16	99.1	81.7	93.3	50.0	50.9	0.01	729.9	WET
17	99.5	85.6	97.2	49.4	49.9	0.01	651.1	WET
18	99.3	83.9	98.9	50.5	51.3	0.02	769.1	WET
19	99.5	76.1	96.7	50.4	50.9	0.01	688.0	WET
20	99.8	76.7	97.2	49.4	49.6	0.01	686.9	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: DAVID DULIN Observer: NONE

Recorded Data Processed by: CHUCK JENKIKNS Date:

Approving Laboratory Official: KEN WEBSTER Date:

Vehicle: 2003 FORD MOTOR CO NHTSA NUMBER: NCAP10
Make: FORD
Model: WINDSTAR SE
Body Style: MINIVAN
Front Cold Tire Pressure: 35 (psi)
Rear Cold Tire Pressure: 35 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 08/20/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 500 NEWTONS

Testing Conditions:
INV DATA, Section 2000, 08/20/03, 11:10:15

Start Odo.: 9313
End Odo.: 9472

Schedule:
LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

Performance Requirements: None

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	100.4	80.6	82.8	54.2	53.7	0.04	410.8	WET
2	99.3	91.7	-17.8	54.5	55.2	0.02	413.2	WET
3	100.1	92.2	-17.8	54.1	54.0	0.01	504.4	WET
4	98.3	97.2	-17.8	53.5	55.5	0.03	467.2	WET
5	99.9	88.9	-17.8	57.1	57.2	0.94	323.7	WET
6	100.1	94.4	-17.8	54.3	54.2	0.03	494.5	WET
7	100.2	90.6	-17.8	55.1	54.8	0.03	342.4	WET
8	99.4	83.9	-17.8	55.0	55.6	0.04	554.0	WET
9	99.6	87.2	-17.8	55.6	55.9	0.01	567.2	WET
10	98.8	94.4	-17.8	55.4	56.7	0.03	568.4	WET
11	100.7	81.1	-17.8	53.3	52.6	0.02	428.8	DRY
12	100.4	91.1	-17.8	50.7	50.3	0.02	564.2	DRY
13	100.3	87.2	-17.8	50.6	50.3	0.40	568.4	DRY
14	100.3	89.4	-17.8	49.5	49.2	0.01	513.5	DRY
15	100.3	87.8	-17.8	50.0	49.7	0.04	459.0	DRY
16	100.4	85.6	-17.8	49.4	49.0	0.02	475.4	DRY
17	100.7	88.3	-17.8	51.0	50.4	0.04	414.3	DRY
18	100.3	92.8	-17.8	48.8	48.5	0.02	497.6	DRY
19	100.1	90.0	-17.8	49.1	49.0	0.02	402.3	DRY
20	101.3	86.7	-17.8	49.4	48.1	0.02	494.0	DRY

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: DAVID DULIN Observer: NONE
Recorded Data Processed by: CHUCK JENKIKNS Date: 8/25/03
Approving Laboratory Official: KEN WEBSTER Date: 9/05/03

Vehicle: 2003 FORD MOTOR CO NHTSA NUMBER: NCAP10

Make: FORD

Model: WINDSTAR SE

Body Style: MINIVAN

Front Cold Tire Pressure: 35 (psi)

Rear Cold Tire Pressure: 35 (psi)

Transportation Research Center, Inc.
10820 State Route 347
East Liberty, Ohio 43319
(937)666-2011 www.trcpg.com

Date Tested: 08/21/03

NCAP TEST OF BRAKE STOPPING DISTANCE @ 670 NEWTONS

Testing Conditions:

INV DATA, Section 3000, 08/21/03, 10:52:59

Start Odo.: 9313

End Odo.: 9472

Schedule:

Performance Requirements: None

LLVW, 20 Stops, 100-0 kph, 500N ± 30N,
in gear, 65 - 95° IBT

STOP #	INITIAL SPD (kph)	IBT Left Front (°C)	IBT Right Front (°C)	Stop Distance (meter)	Corrected Stop Distance (meter)	TIME TO 500N (second)	PEDAL FORCE AT .75 SEC (N)	Pavement Condition
1	100.7	80.6	-17.8	54.4	53.6	0.03	627.9	WET
2	99.3	83.9	-17.8	54.5	55.2	0.04	697.4	WET
3	99.9	88.3	-17.8	54.7	54.9	0.02	623.0	WET
4	99.9	91.1	-17.8	47.9	48.1	0.01	626.4	DRY
5	99.5	89.4	-17.8	49.9	50.4	0.02	616.7	DRY
6	100.2	89.4	-17.8	48.7	48.5	0.01	609.8	DRY
7	99.4	93.9	-17.8	48.0	48.6	0.02	662.1	DRY
8	100.7	93.9	-17.8	48.6	48.0	0.02	655.2	DRY
9	99.9	85.6	-17.8	47.7	47.8	0.01	645.9	DRY
10	100.0	90.0	-17.8	47.5	47.5	0.01	654.1	DRY
11	99.5	88.3	-17.8	47.5	47.9	0.01	644.4	DRY
12	99.1	92.8	-17.8	47.7	48.6	0.01	593.7	DRY
13	99.6	95.6	-17.8	48.3	48.7	0.01	619.7	DRY
14	100.2	85.0	-17.8	54.9	54.7	0.02	649.2	WET
15	99.6	85.6	-17.8	56.2	56.7	0.03	677.0	WET
16	100.5	88.9	-17.8	55.4	54.9	0.03	559.8	WET
17	99.6	86.7	-17.8	54.6	55.0	0.02	691.9	WET
18	98.6	82.2	-17.8	55.7	57.3	0.01	680.6	WET
19	99.0	91.1	-17.8	53.7	54.8	0.02	723.4	WET
20	100.3	85.6	-17.8	56.1	55.7	0.01	646.2	WET

DATA INDICATES COMPLIANCE: YES ( ) NO ( ) NO REQUIREMENTS (X)

Driver: DAVID DULIN Observer: NONE

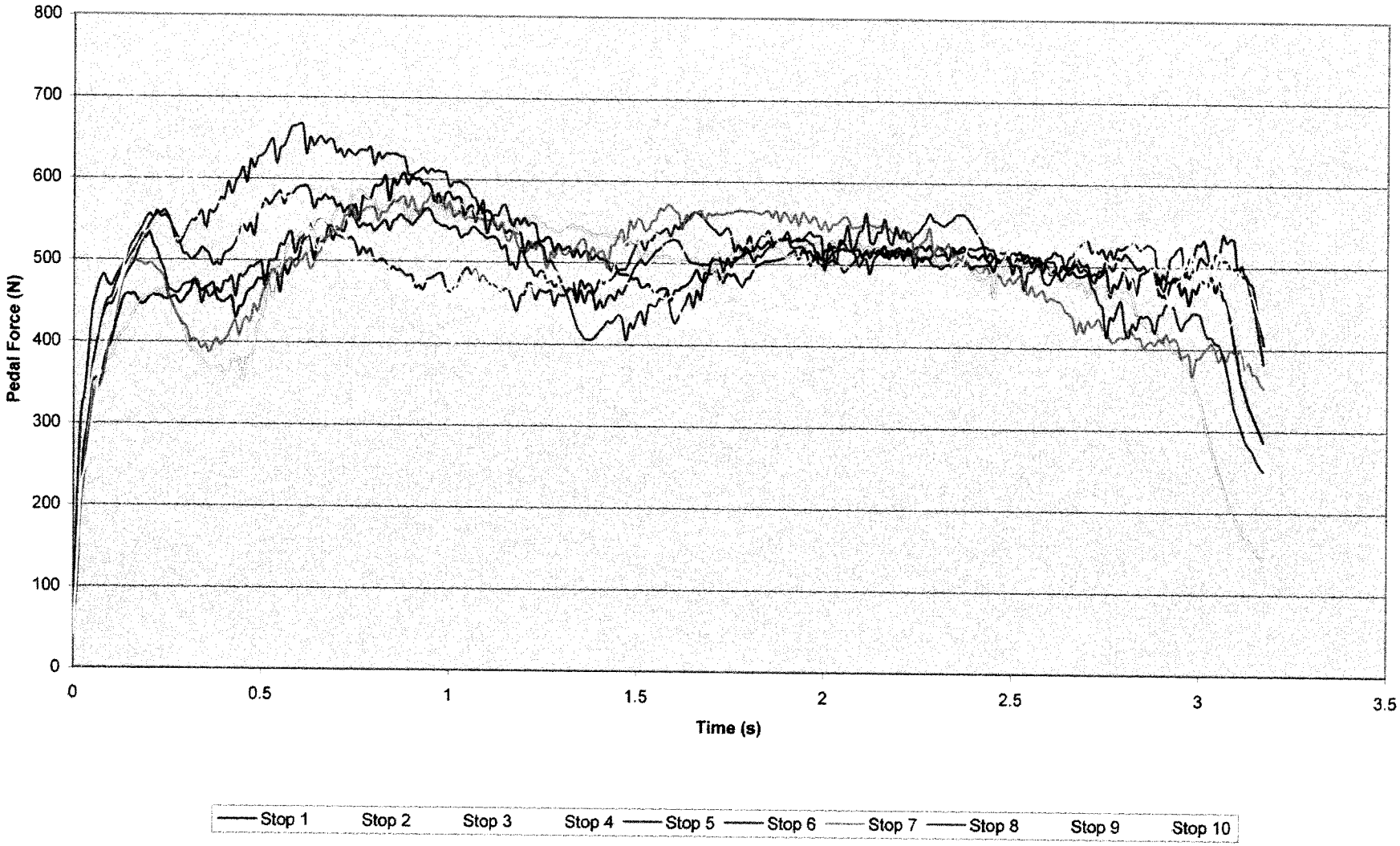
Recorded Data Processed by: CHUCK JENKIKNS Date: 8/25/03

Approving Laboratory Official: KEN WEBSTER Date: 9/05/03

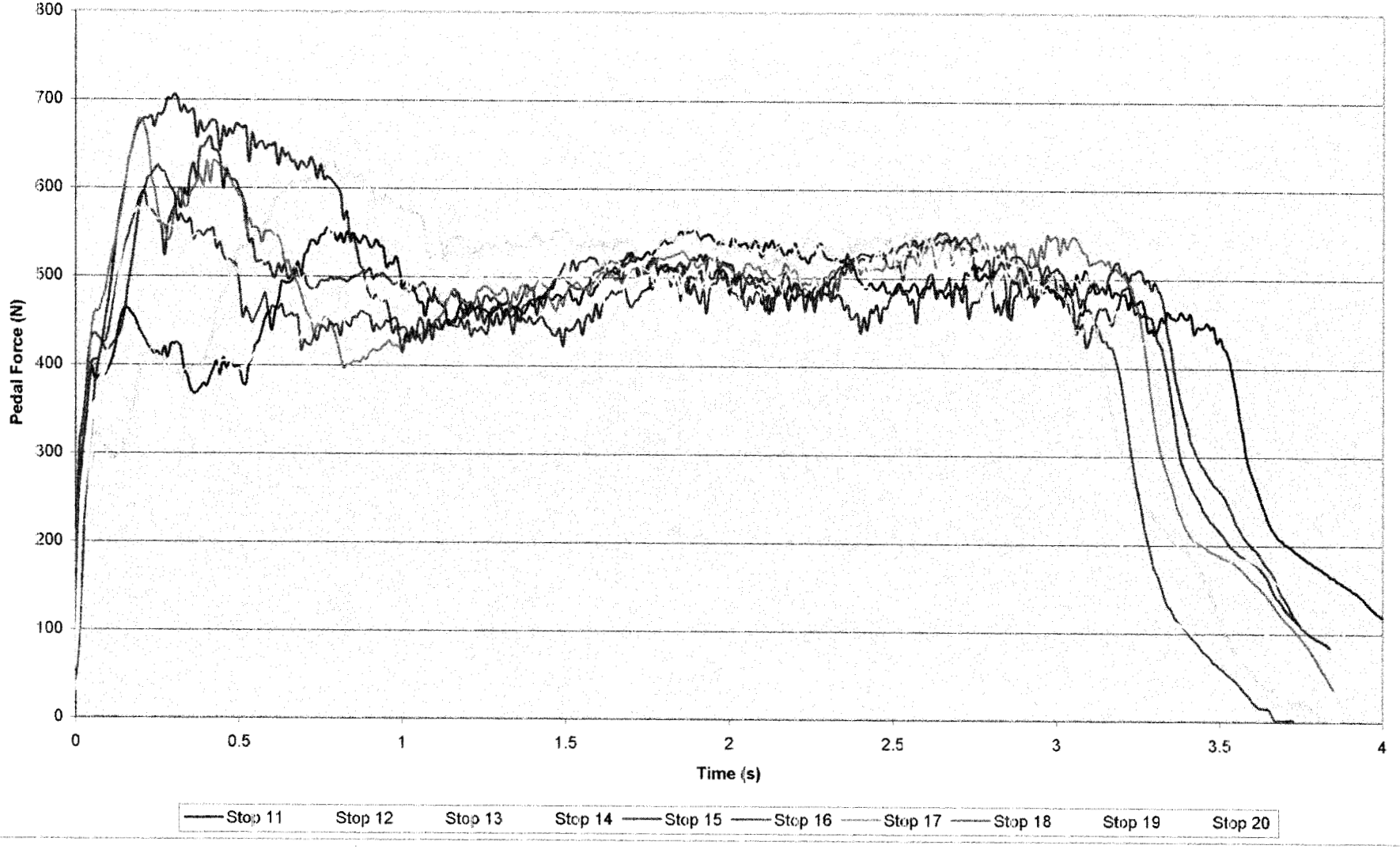
APPENDIX F

Brake Pedal Force Plots

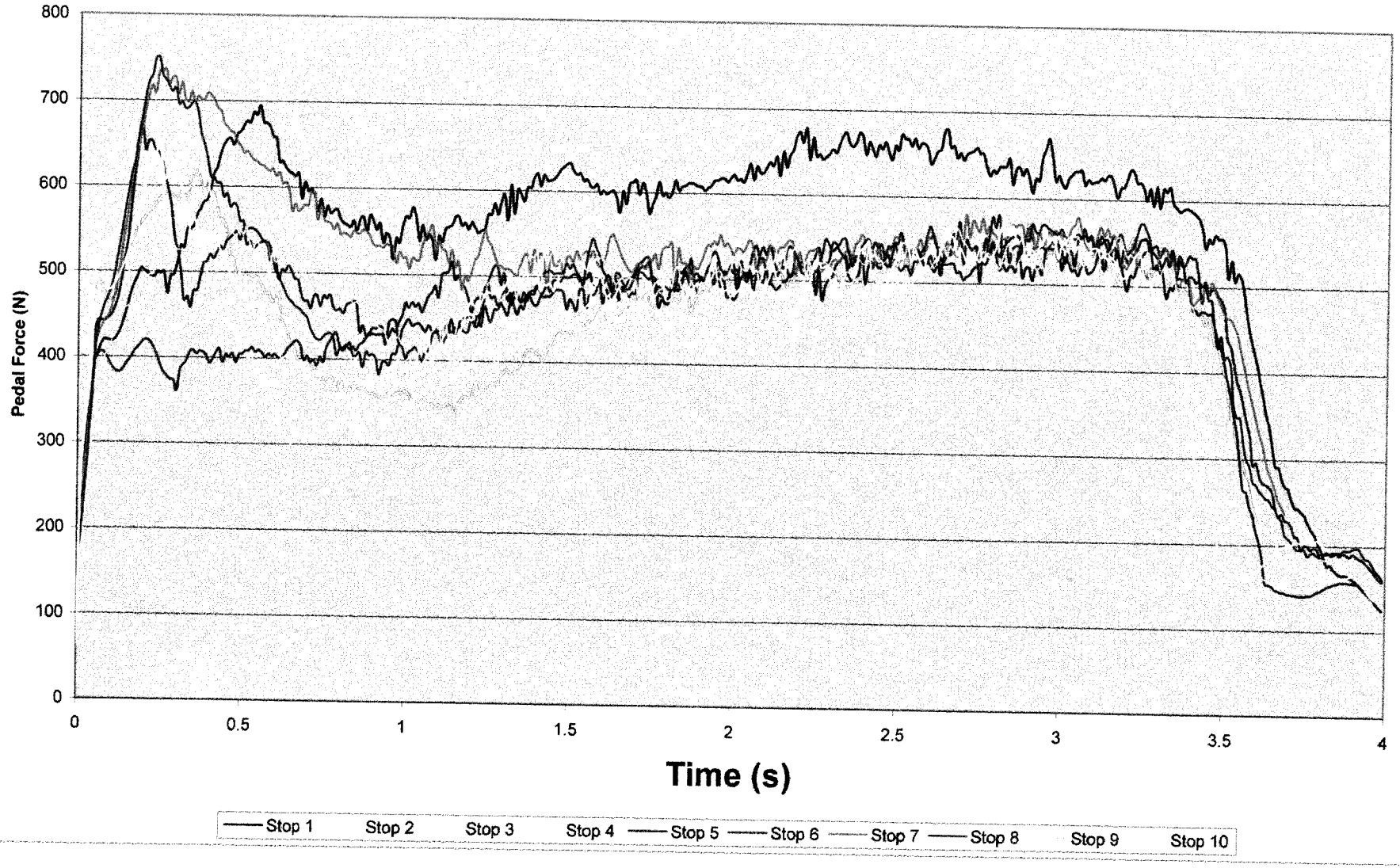
NCAP 1 - Acura RSX - 500 N Dry



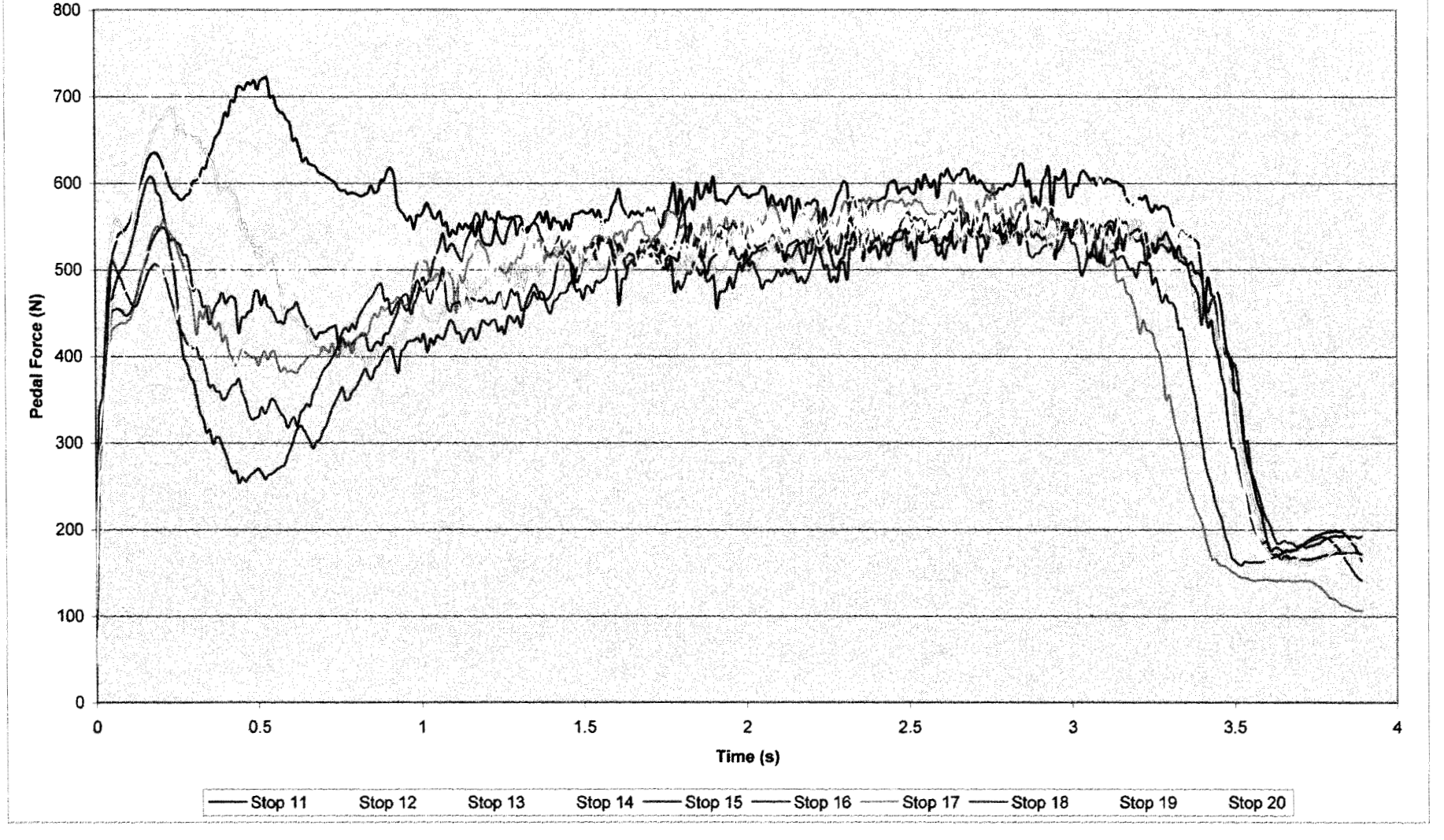
NCAP 1 - Acura RSX - 500 N Wet



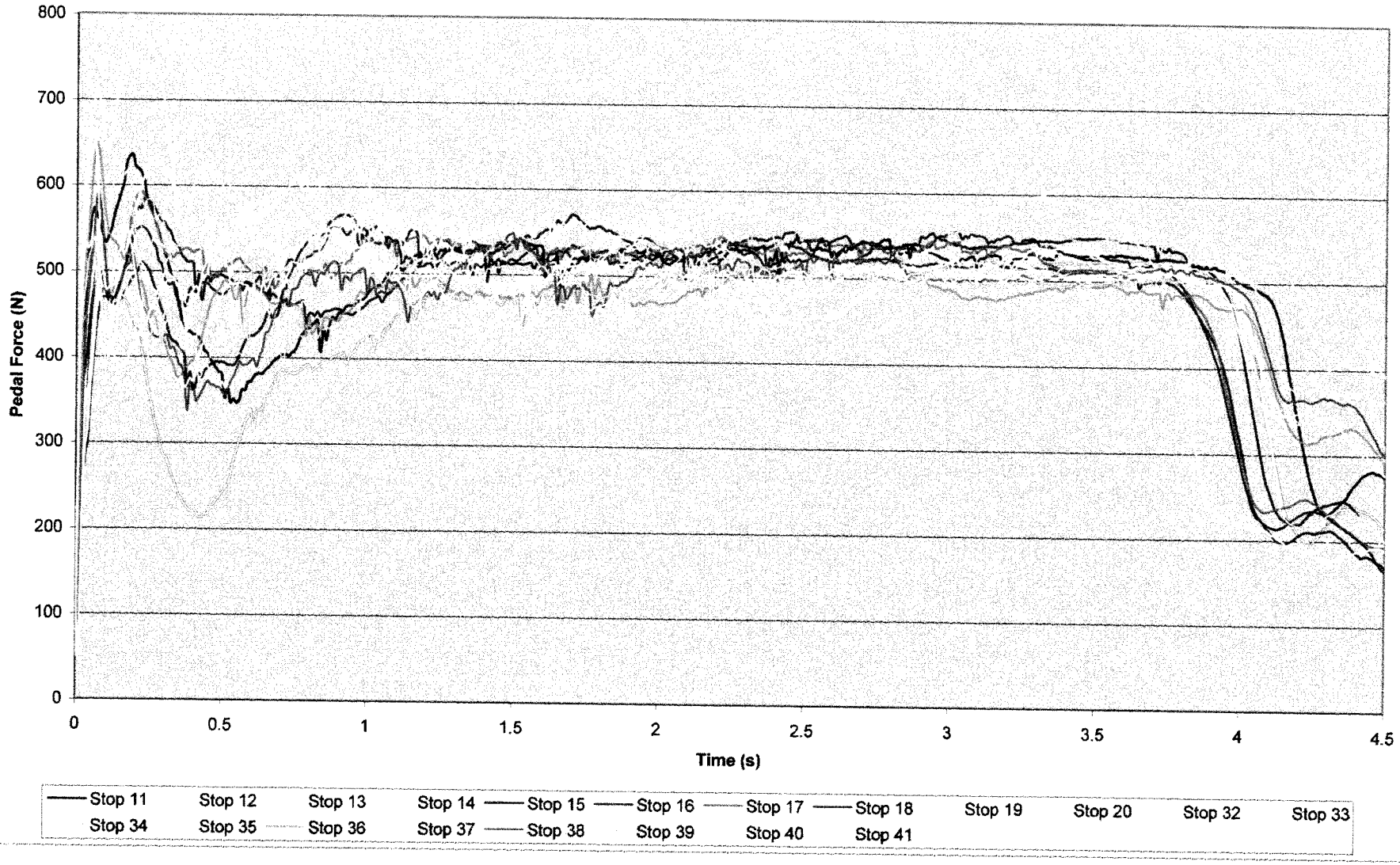
NCAP 2 - Pontiac Bonneville - 500 N Dry



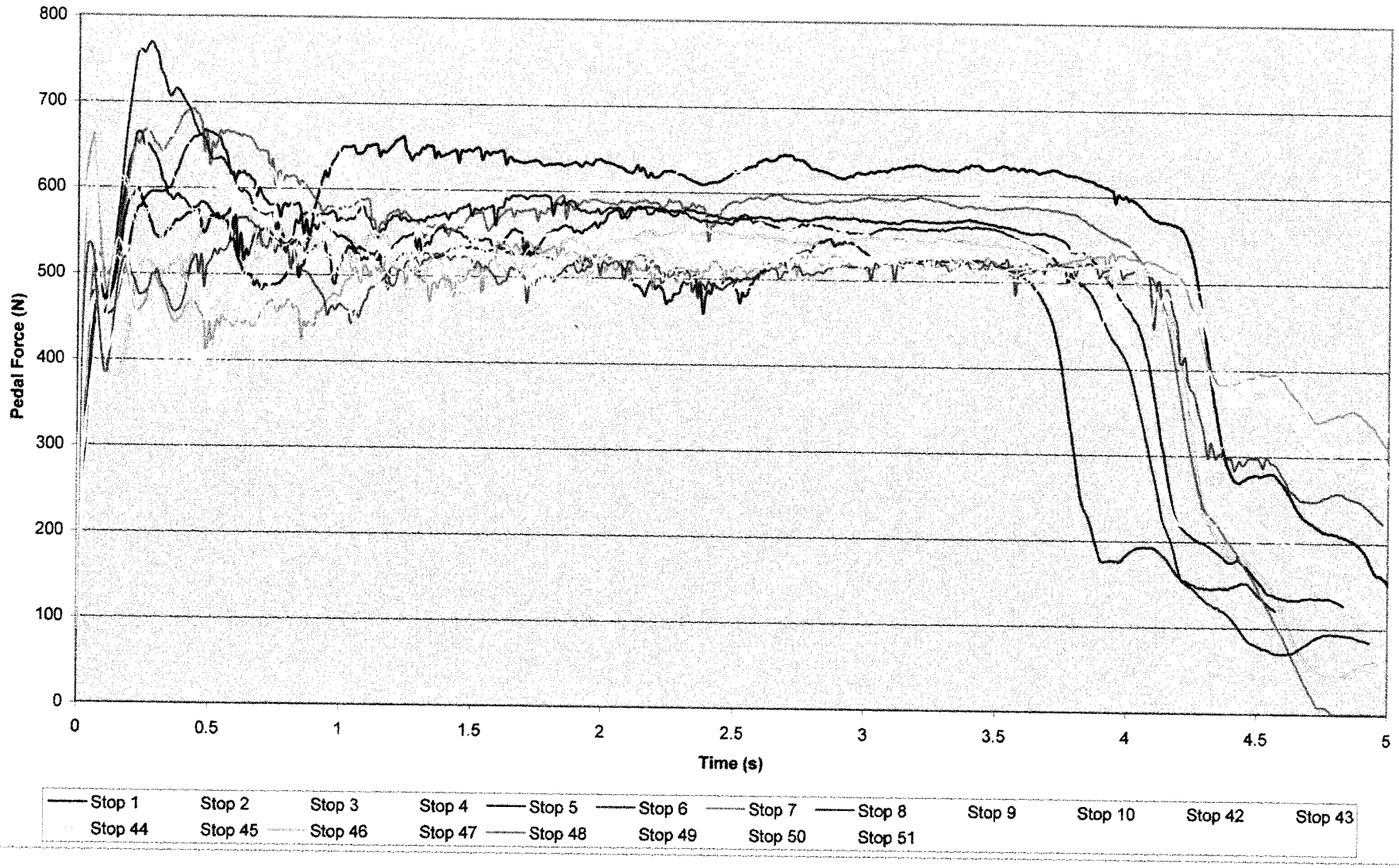
NCAP 2 - Pontiac Bonneville - 500 N Wet



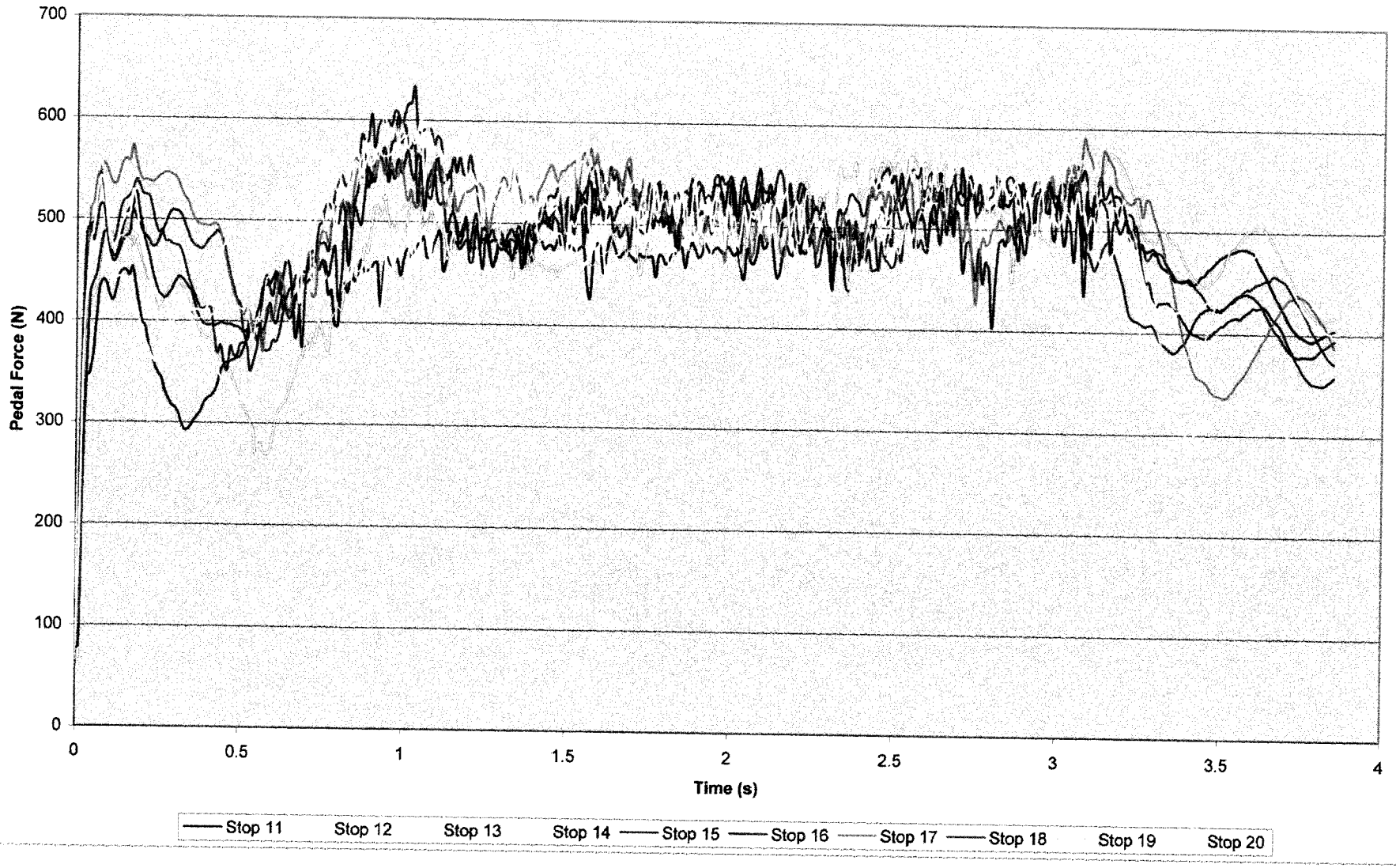
NCAP 3 - Chevrolet Tahoe - 500 N Dry



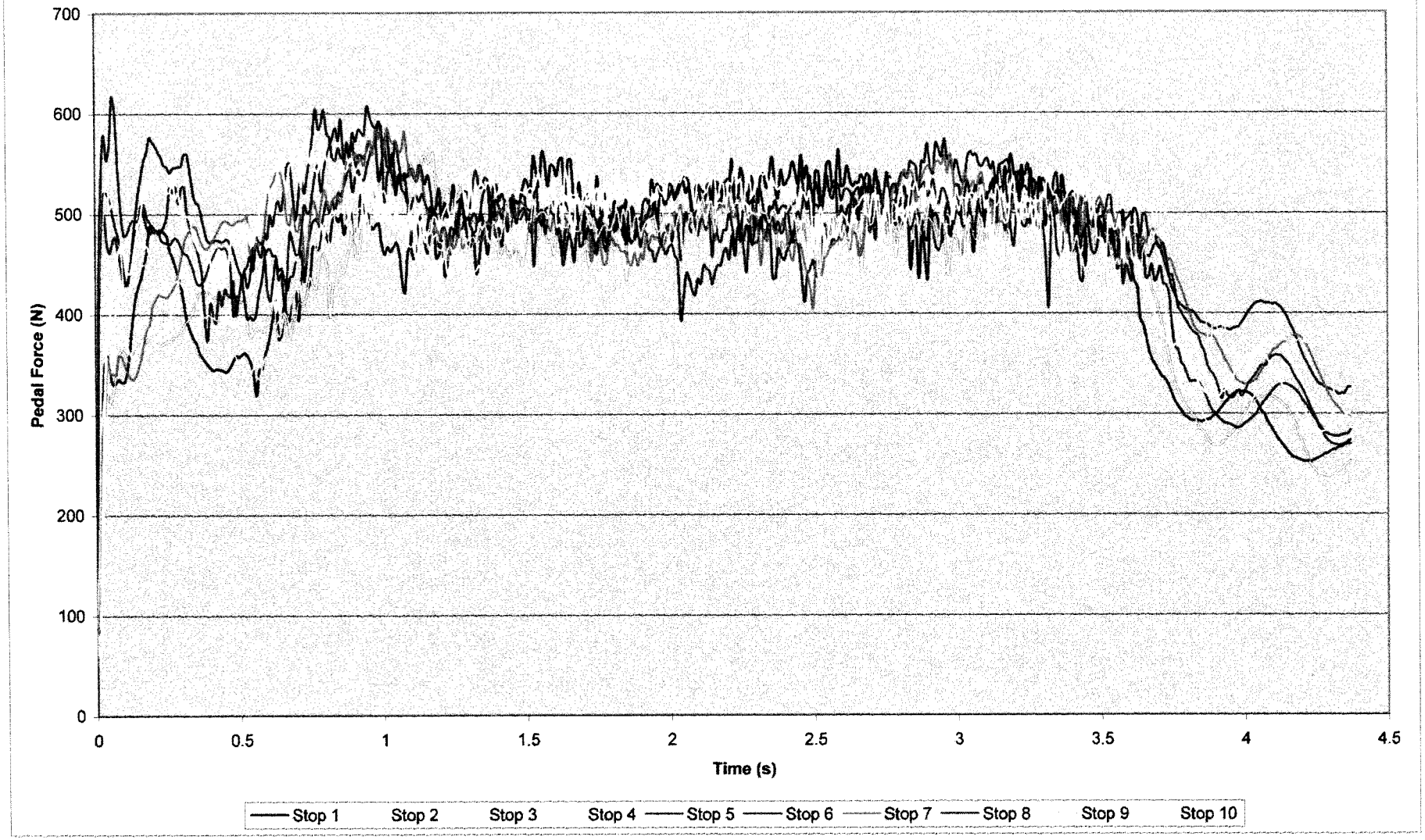
NCAP 3 - Chevrolet Tahoe - 500 N Wet



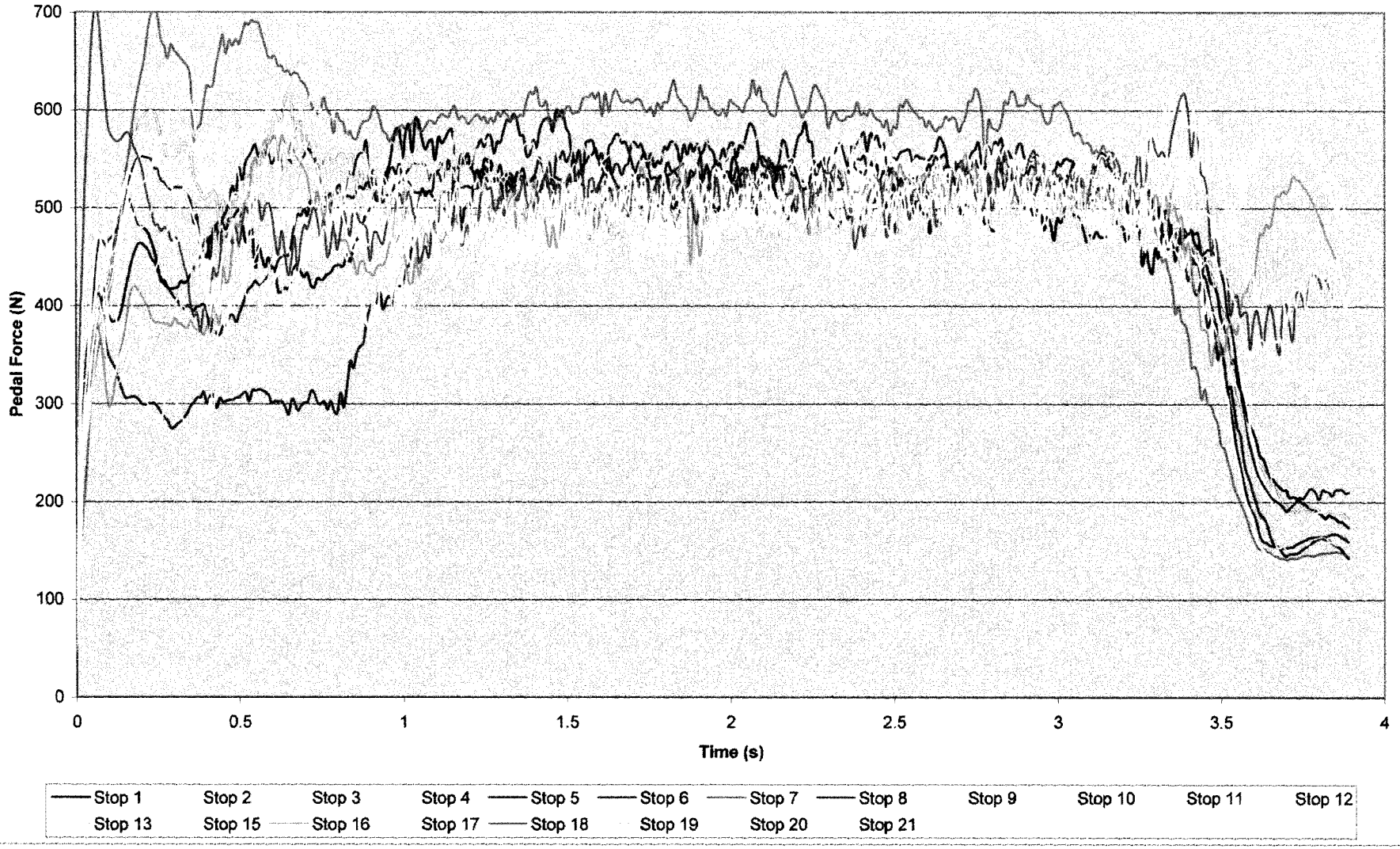
NCAP 4 - Jeep Grand Cherokee - 500 N Dry



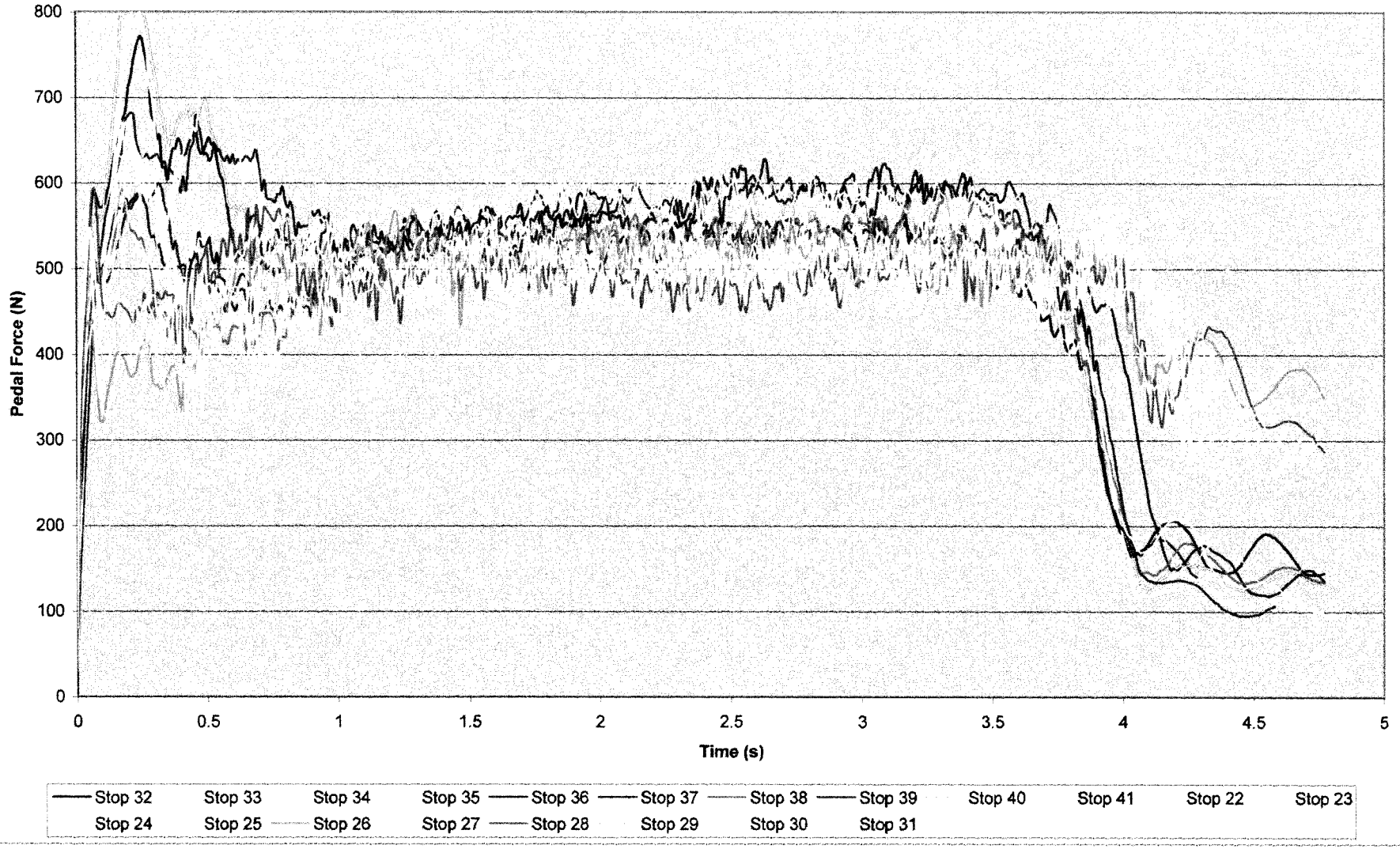
NCAP 4 - Jeep Grand Cherokee - 500 N Wet



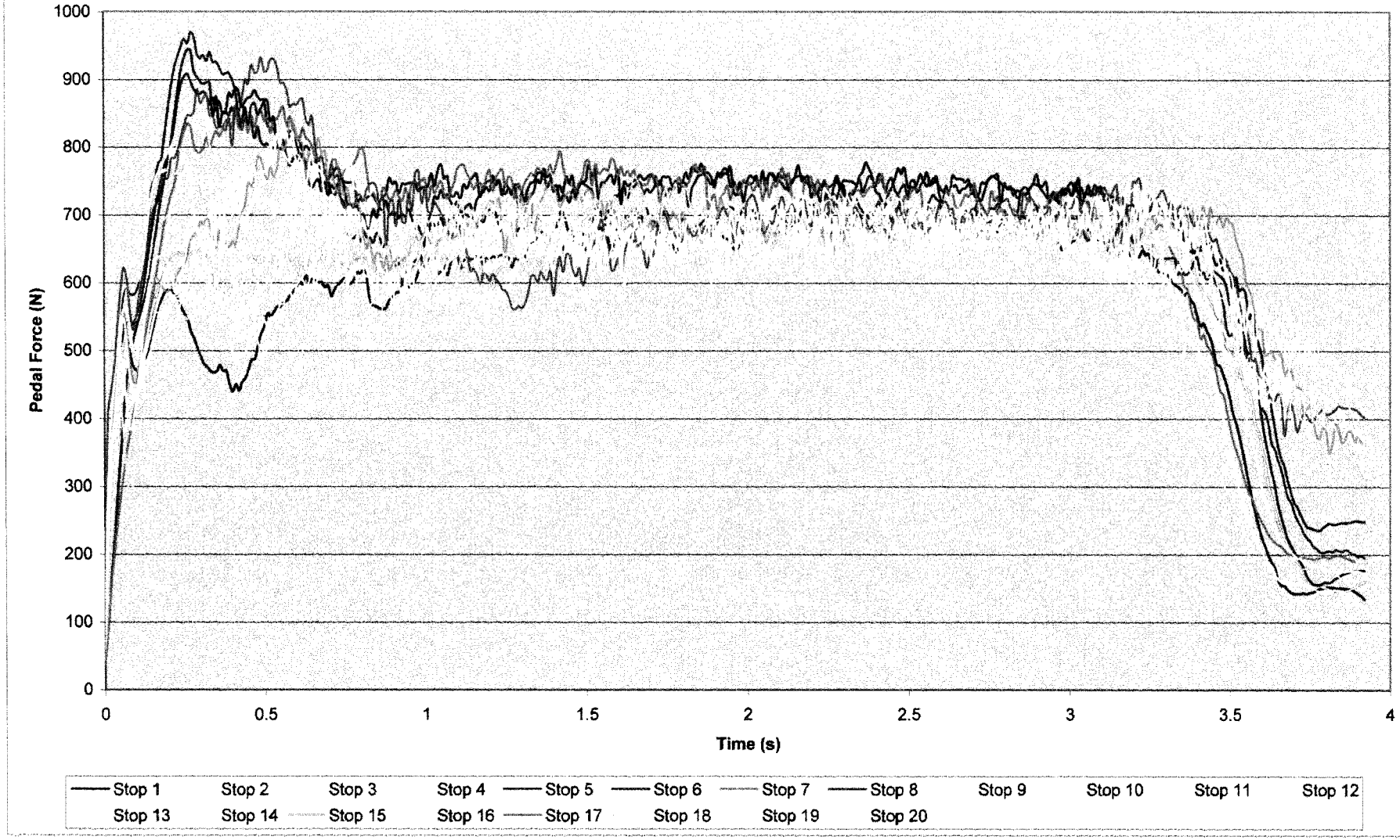
NCAP 5 - Ford Taurus - 500 N Dry



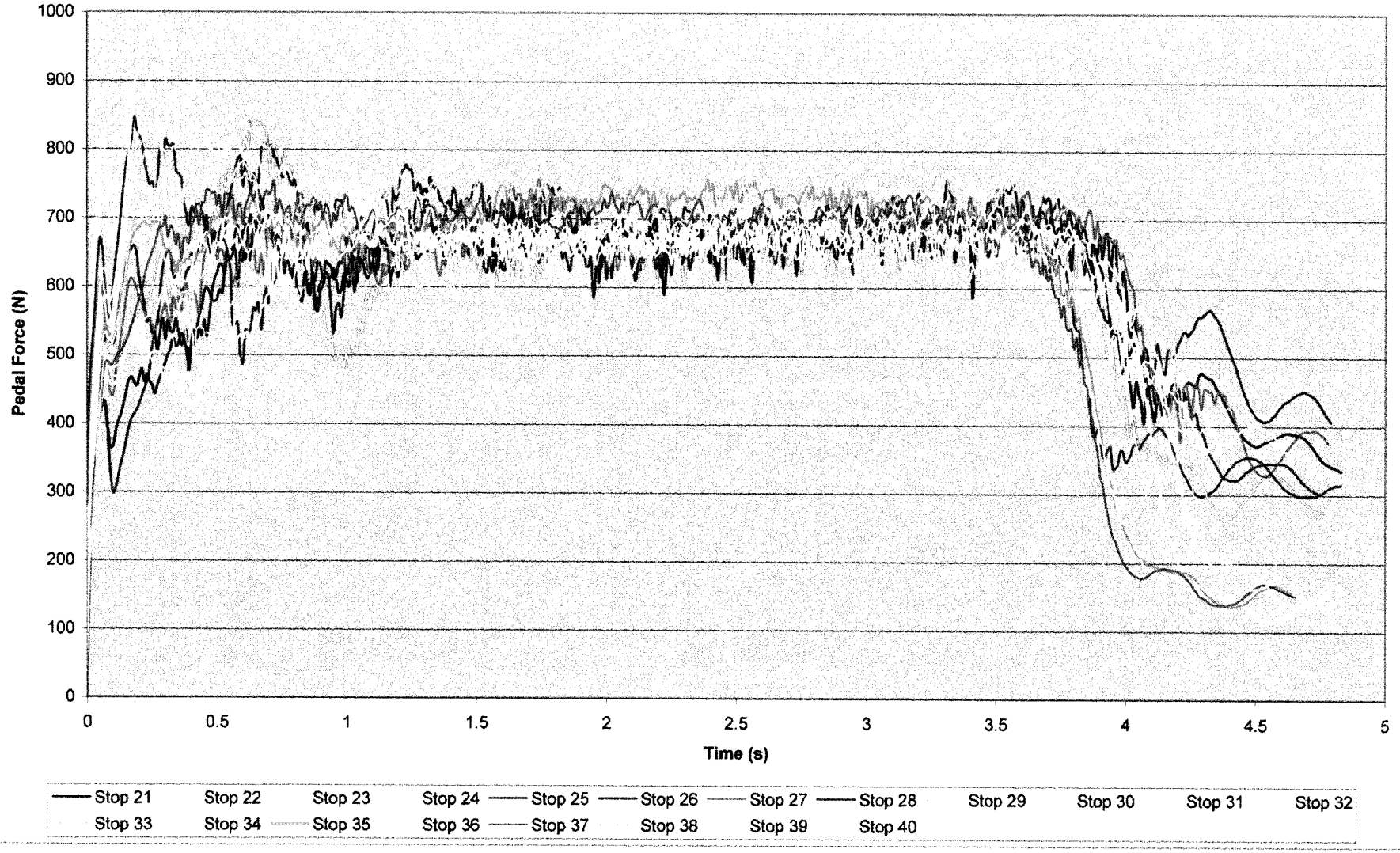
NCAP 5 - Ford Taurus - 500 N Wet



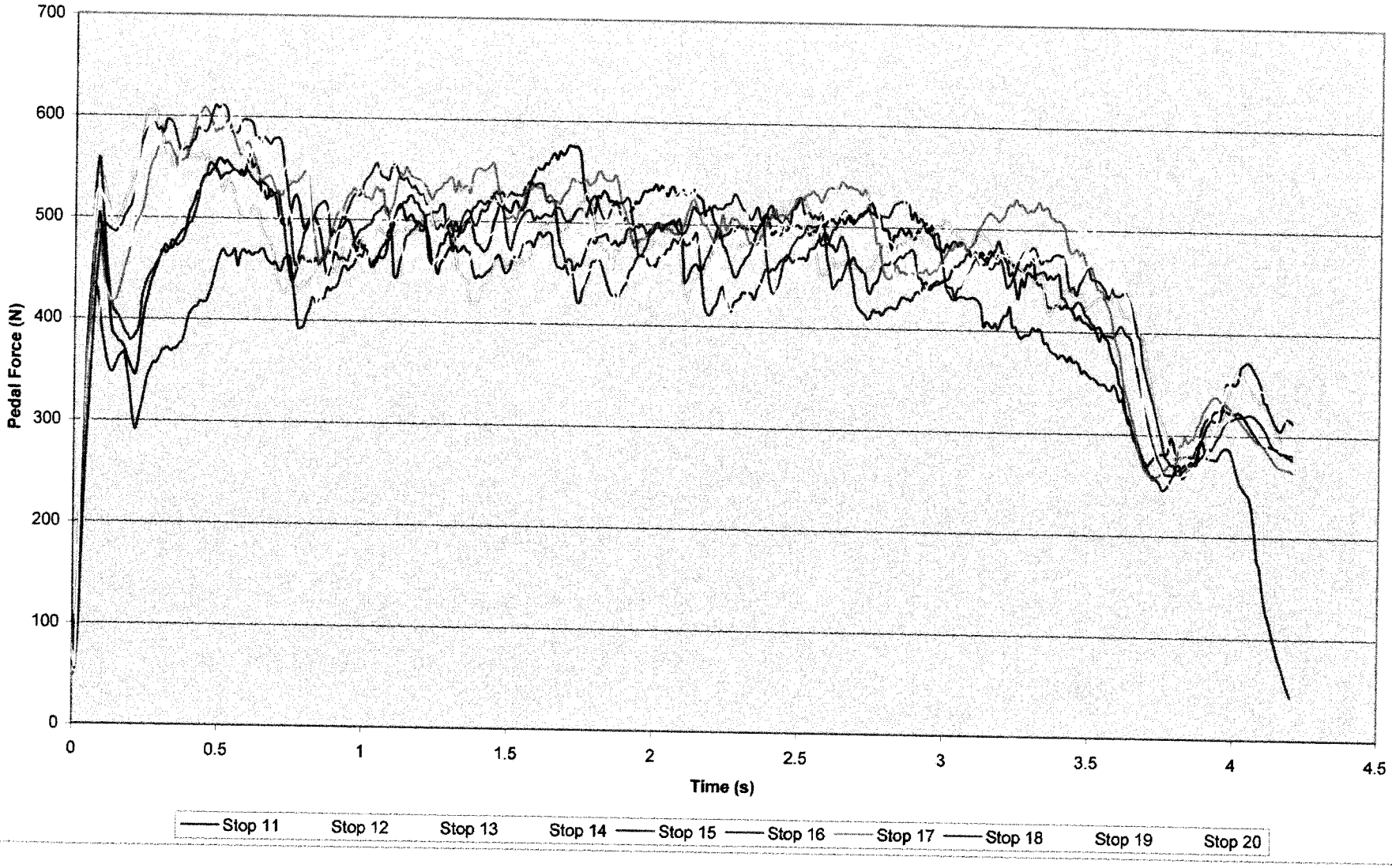
NCAP 5 - Ford Taurus - 670 N Dry



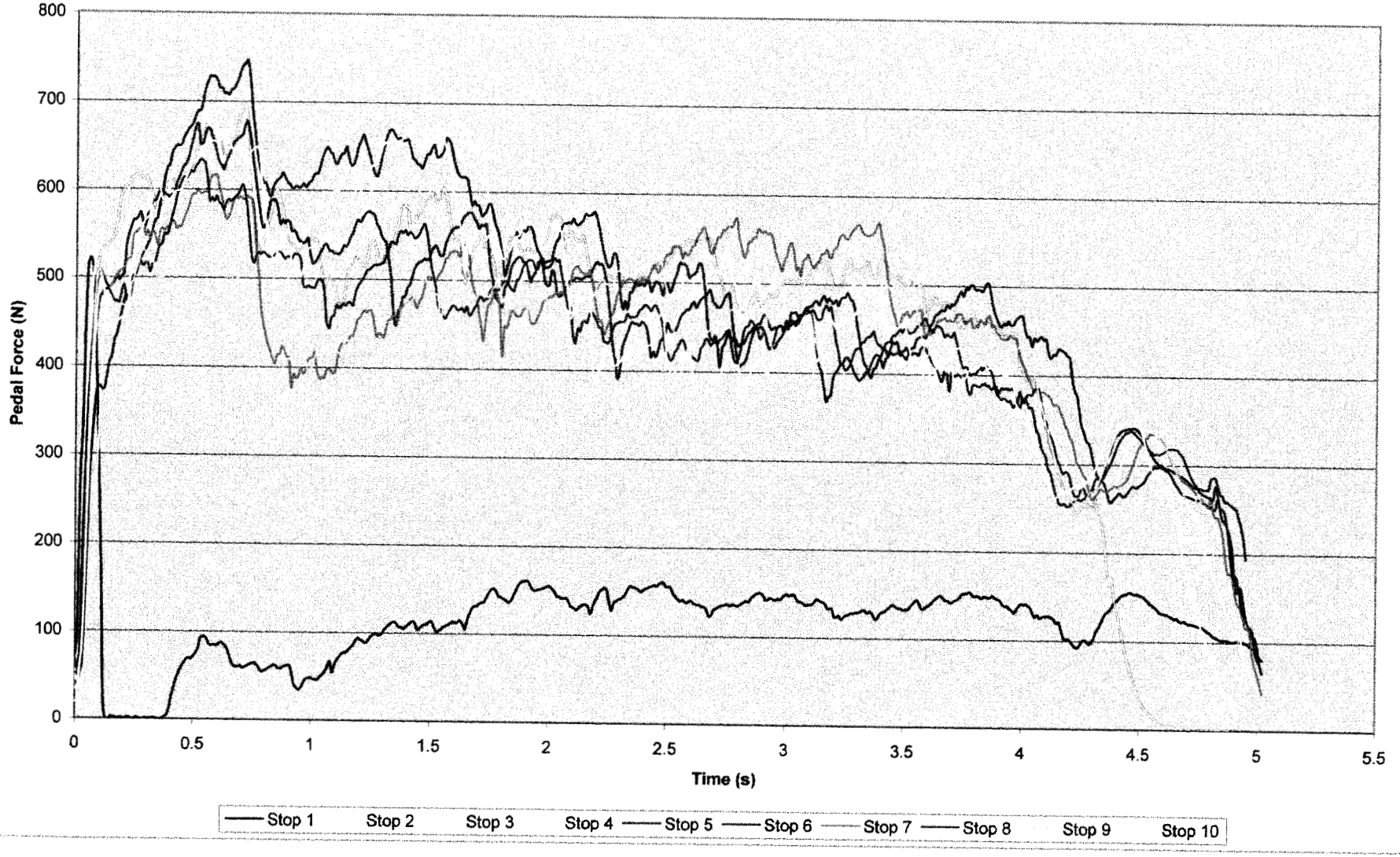
NCAP 5 - Ford Taurus - 670N Wet



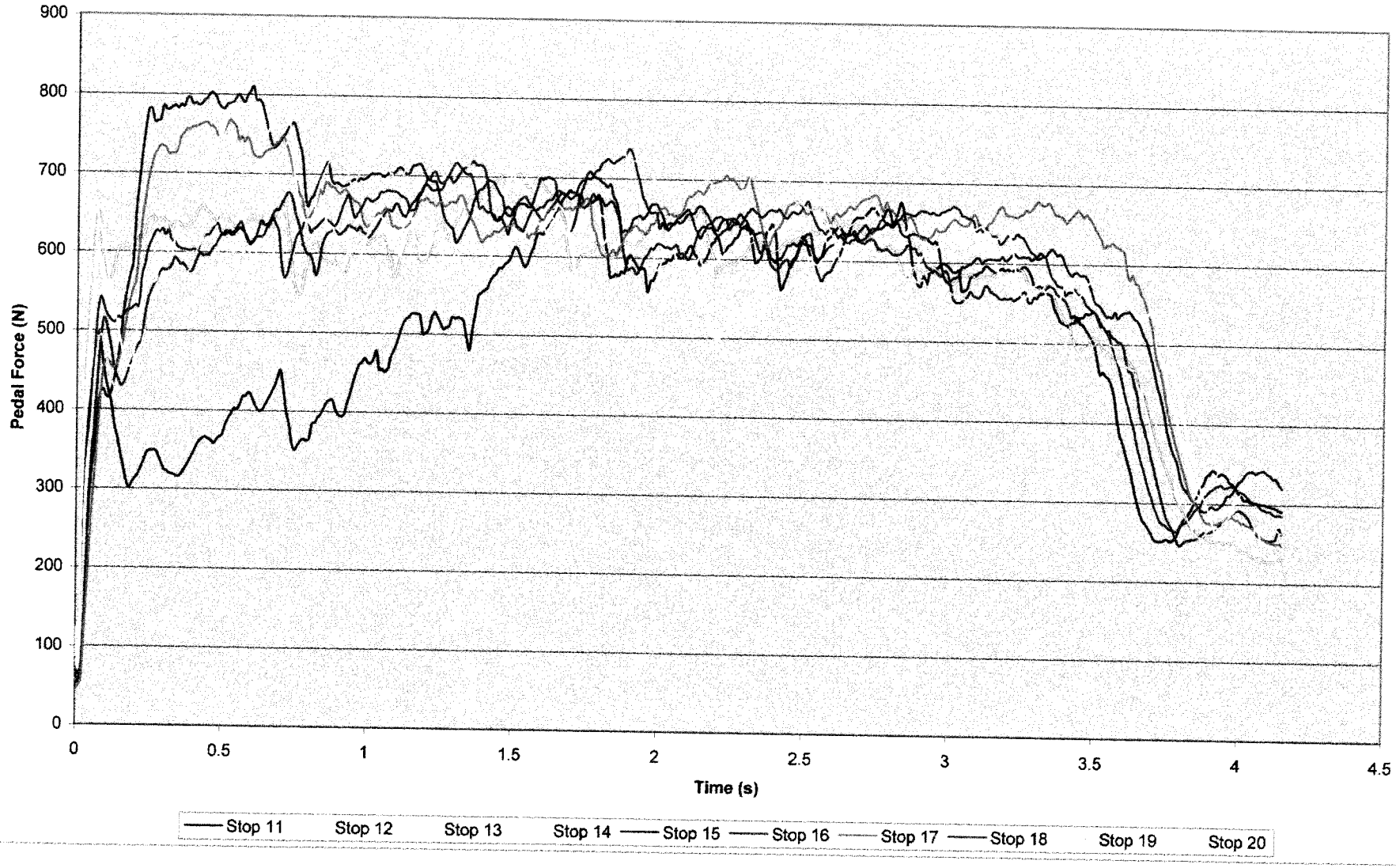
NCAP 6 - Chevrolet Silverado - 500 N Dry



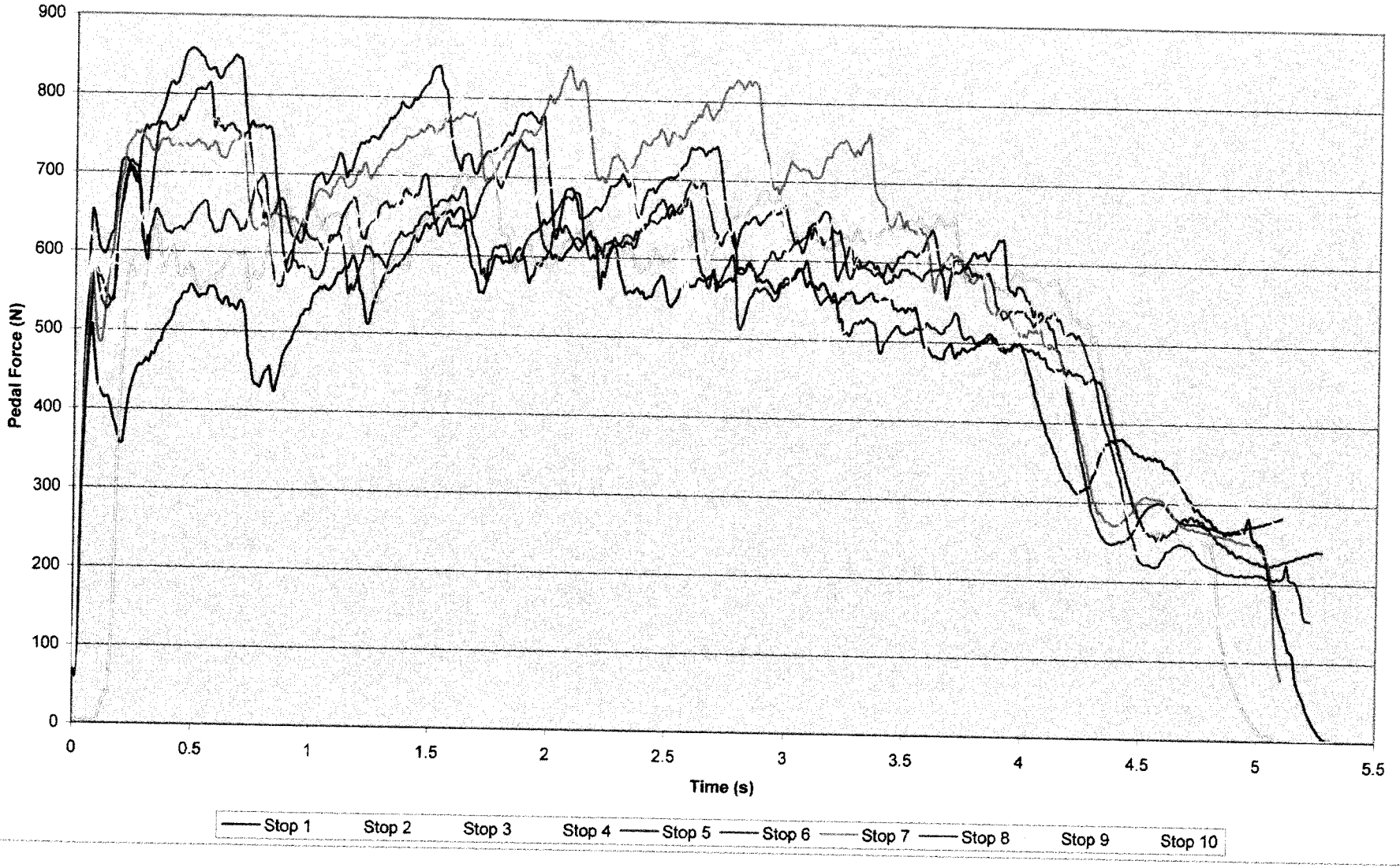
NCAP 6 - Chevrolet Silverado - 500 N Wet



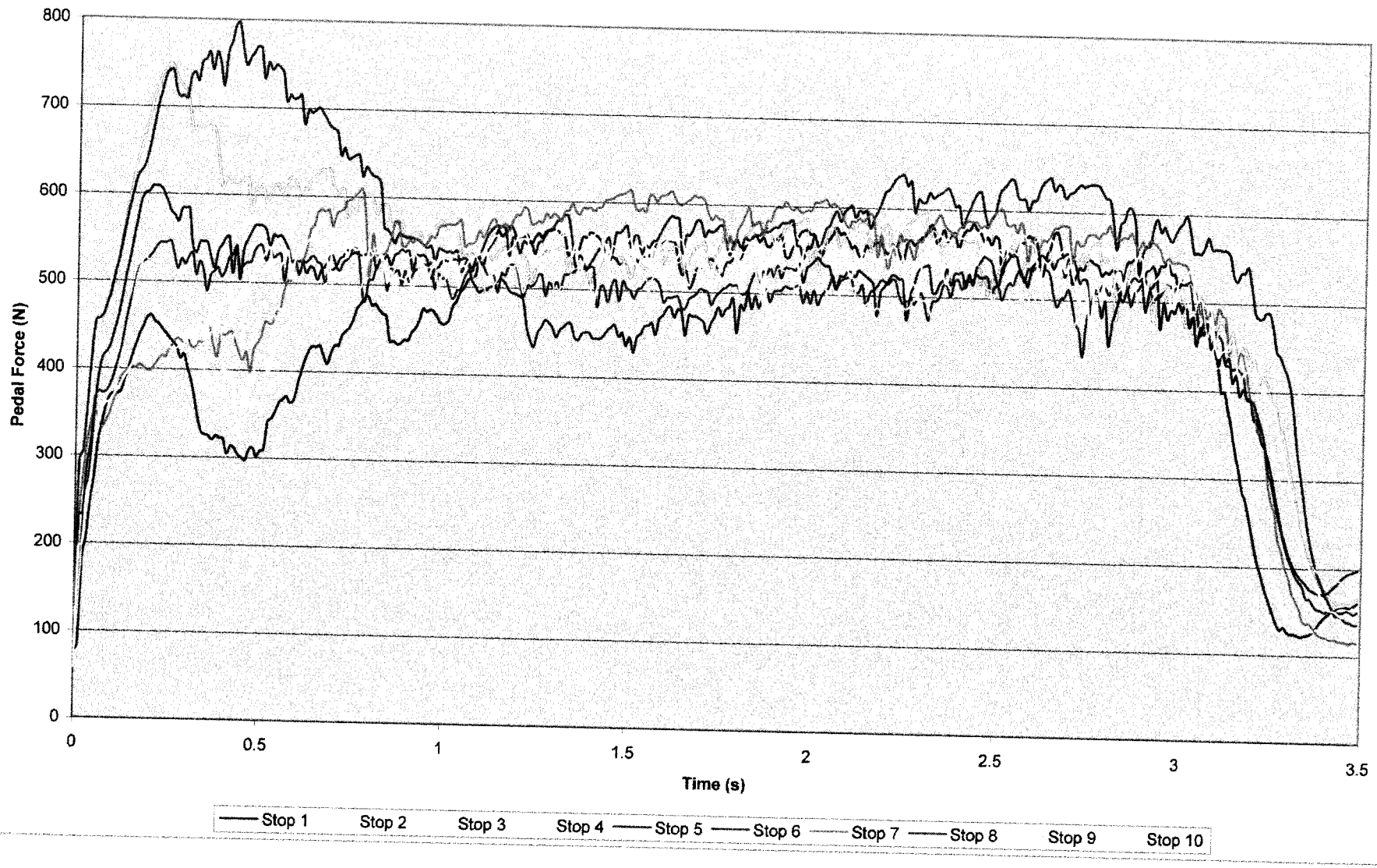
NCAP 6 - Chevrolet Silverado - 670 N Dry



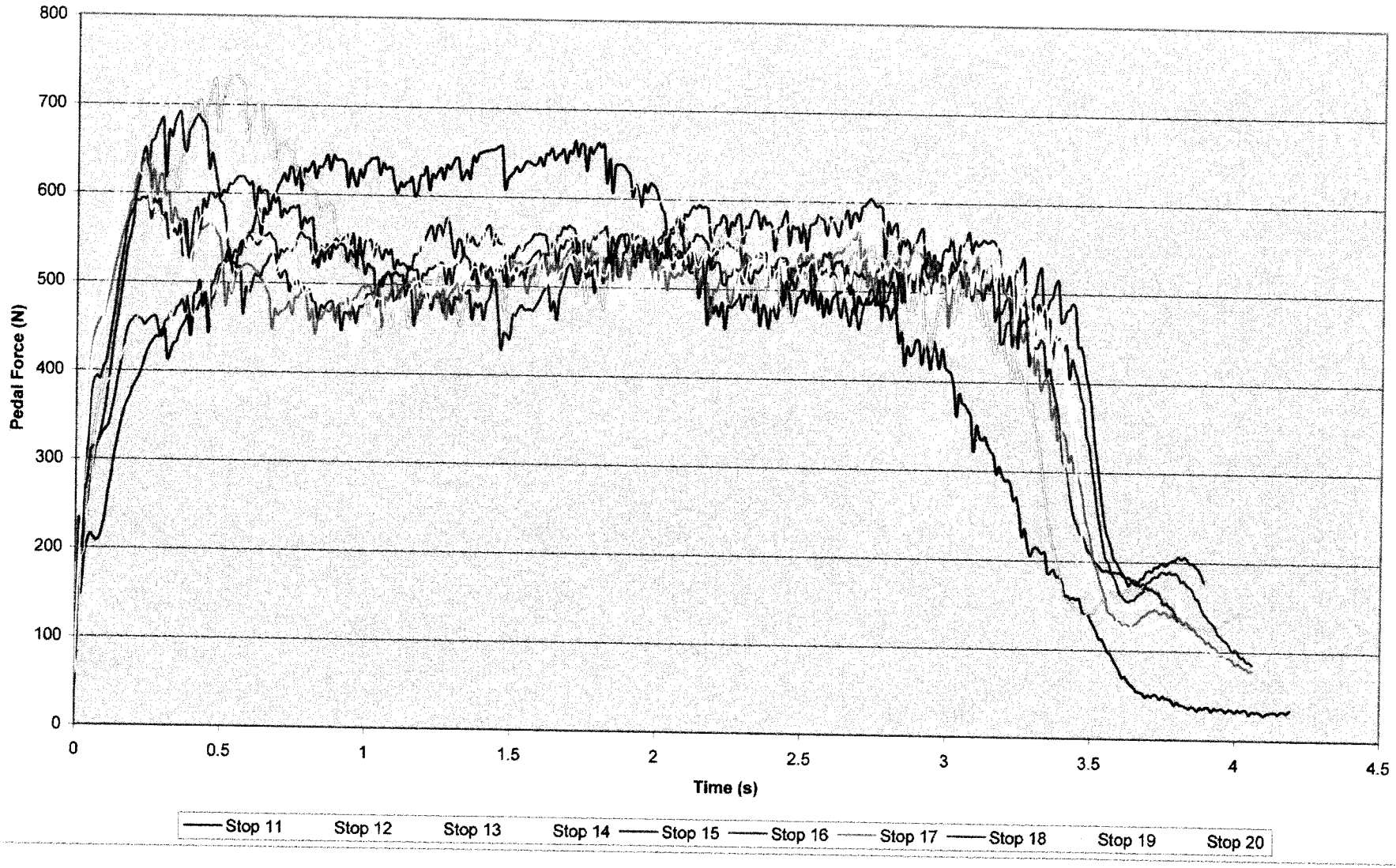
NCAP 6 - Chevrolet Silverado - 670 N Wet



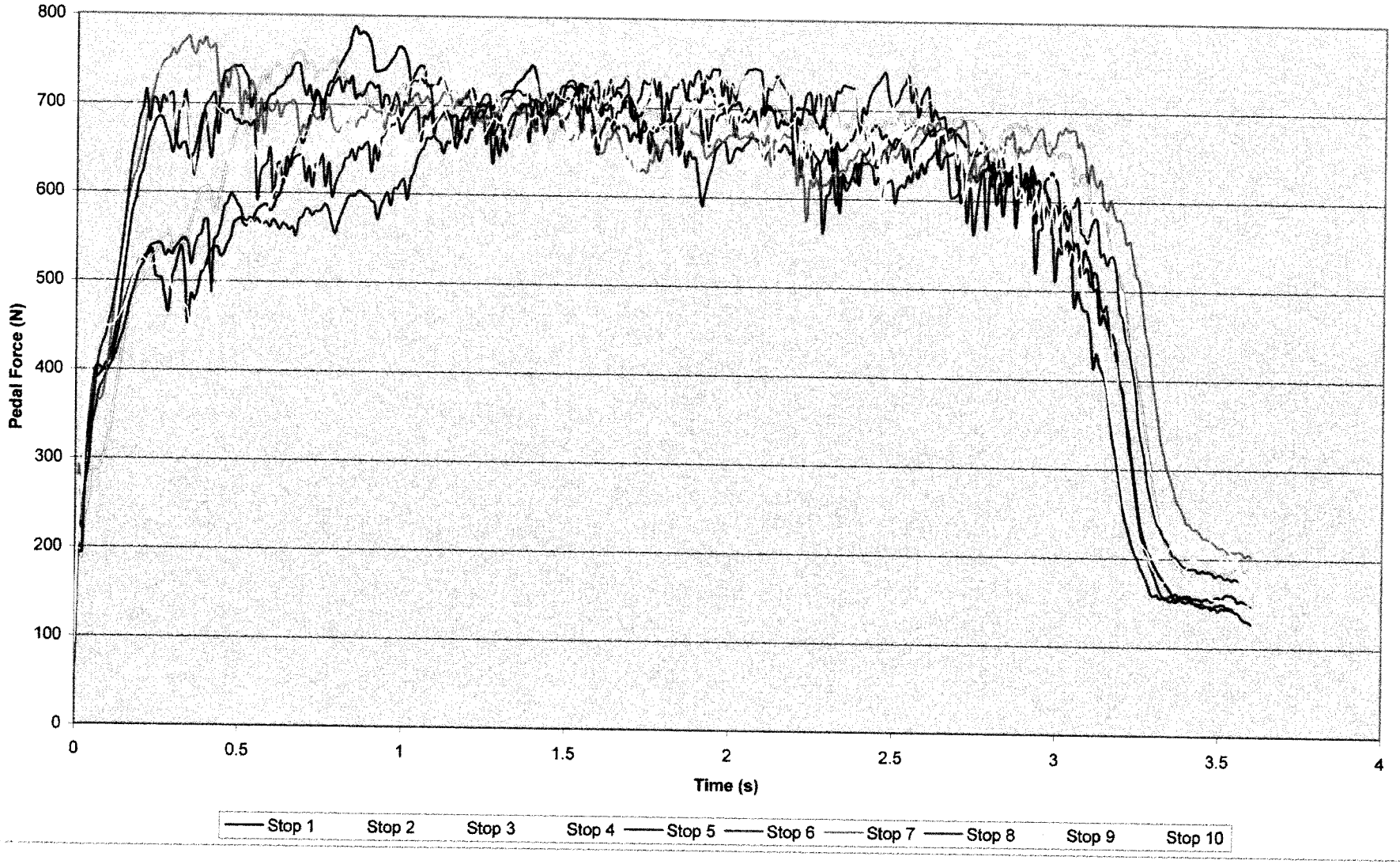
NCAP 7 - Nissan Maxima - 500 N Dry



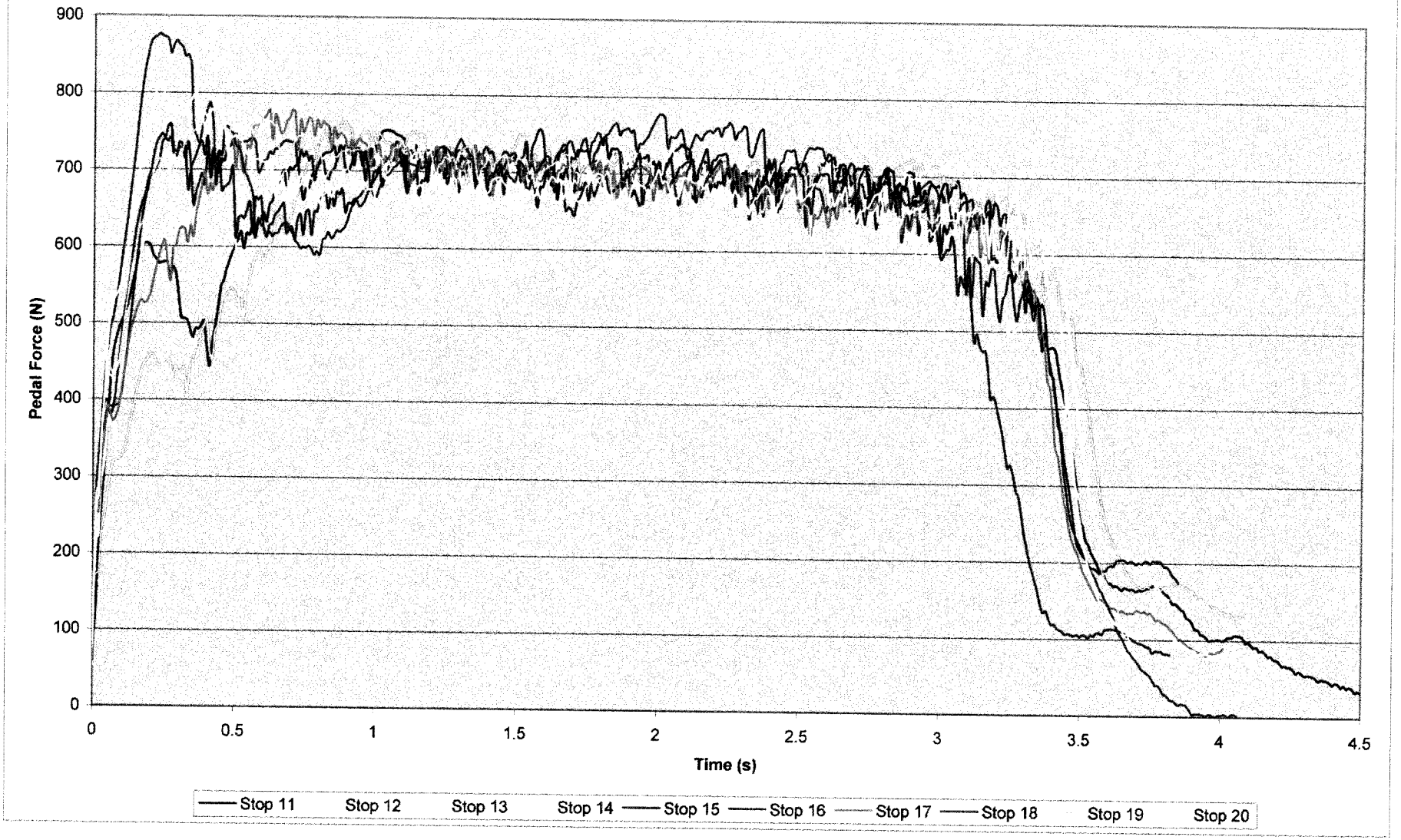
NCAP 7 - Nissan Maxima - 500N Wet



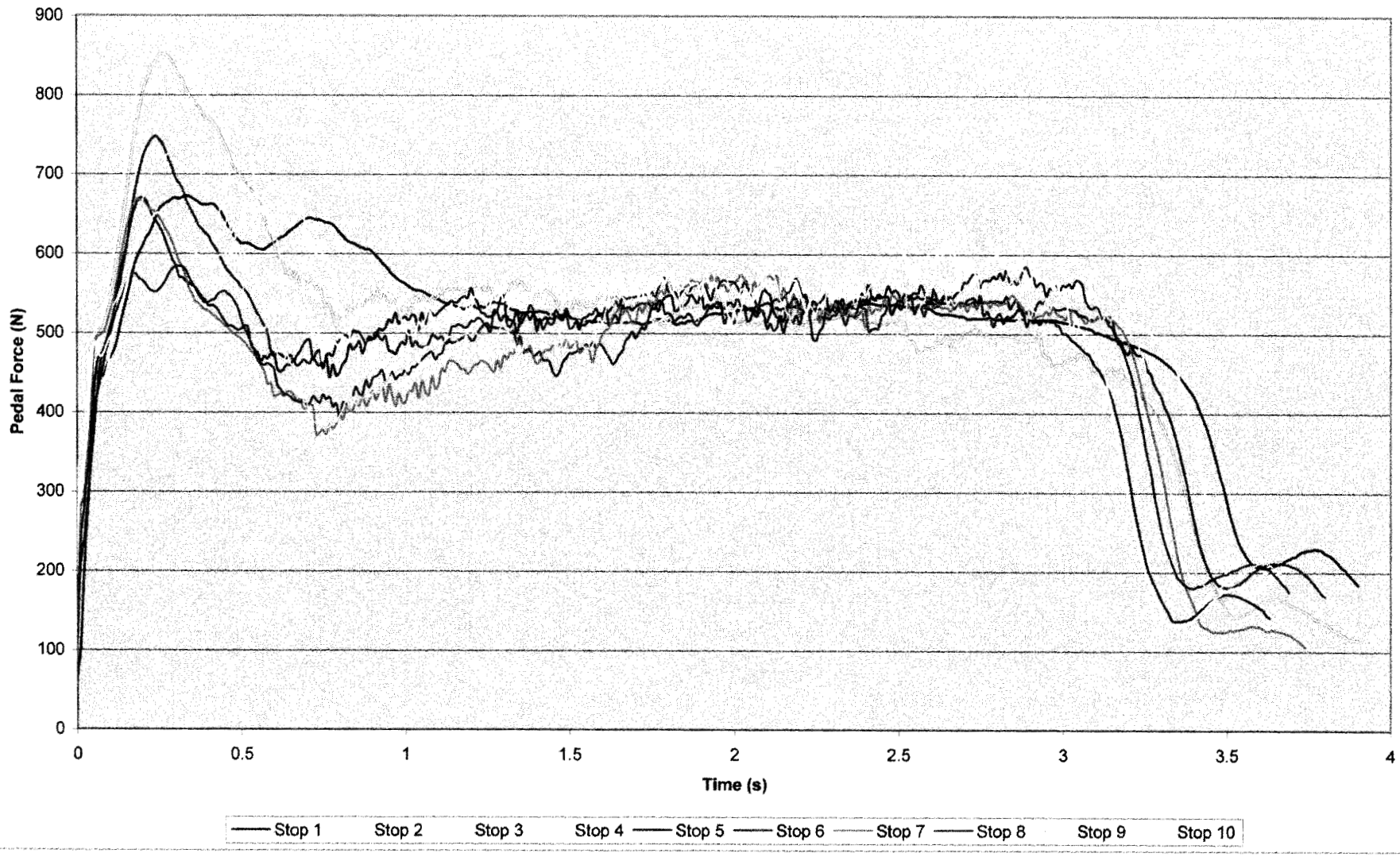
NCAP 7 - Nissan Maxima - 670 N Dry



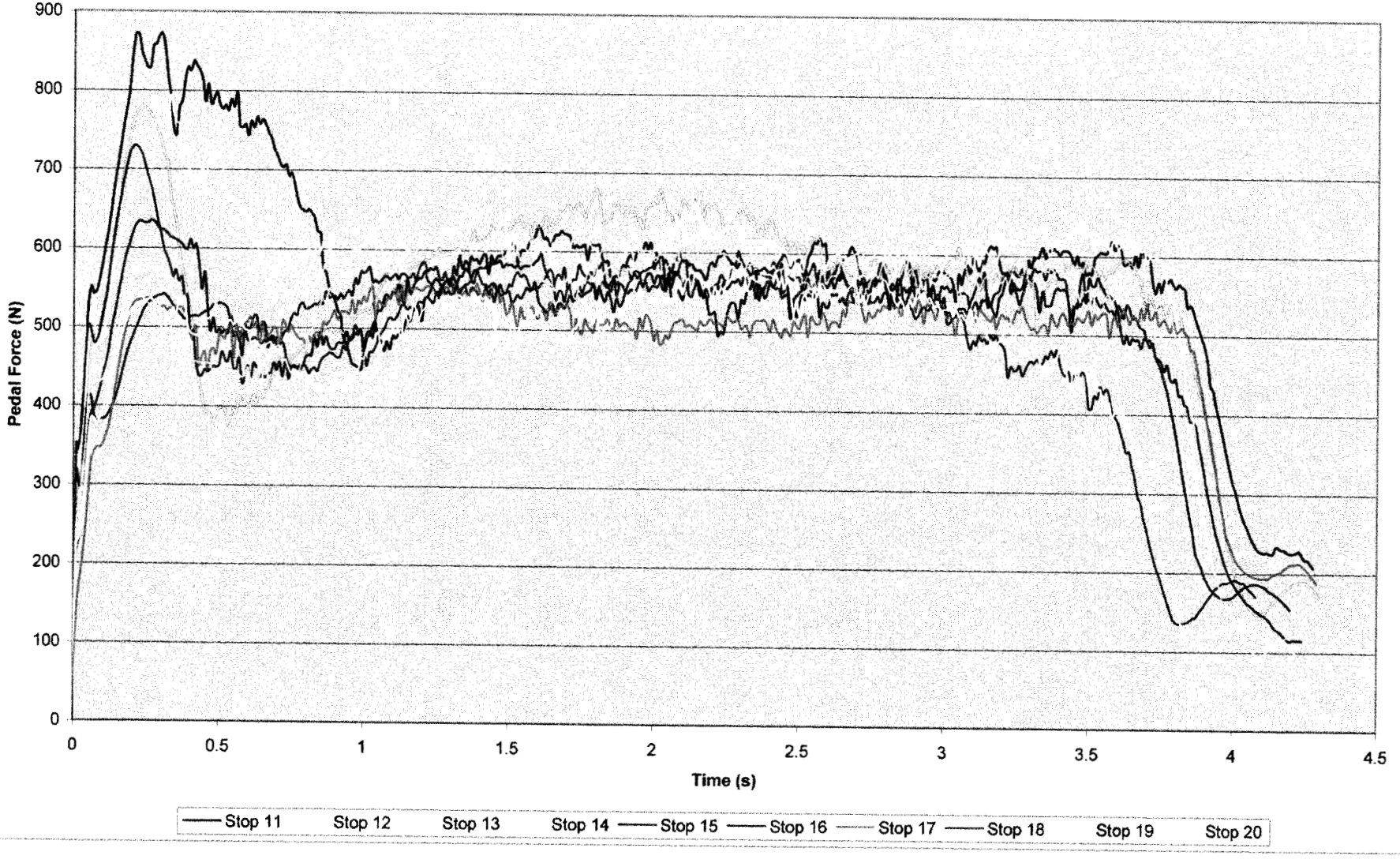
NCAP 7 - Nissan Maxima - 670 N Wet



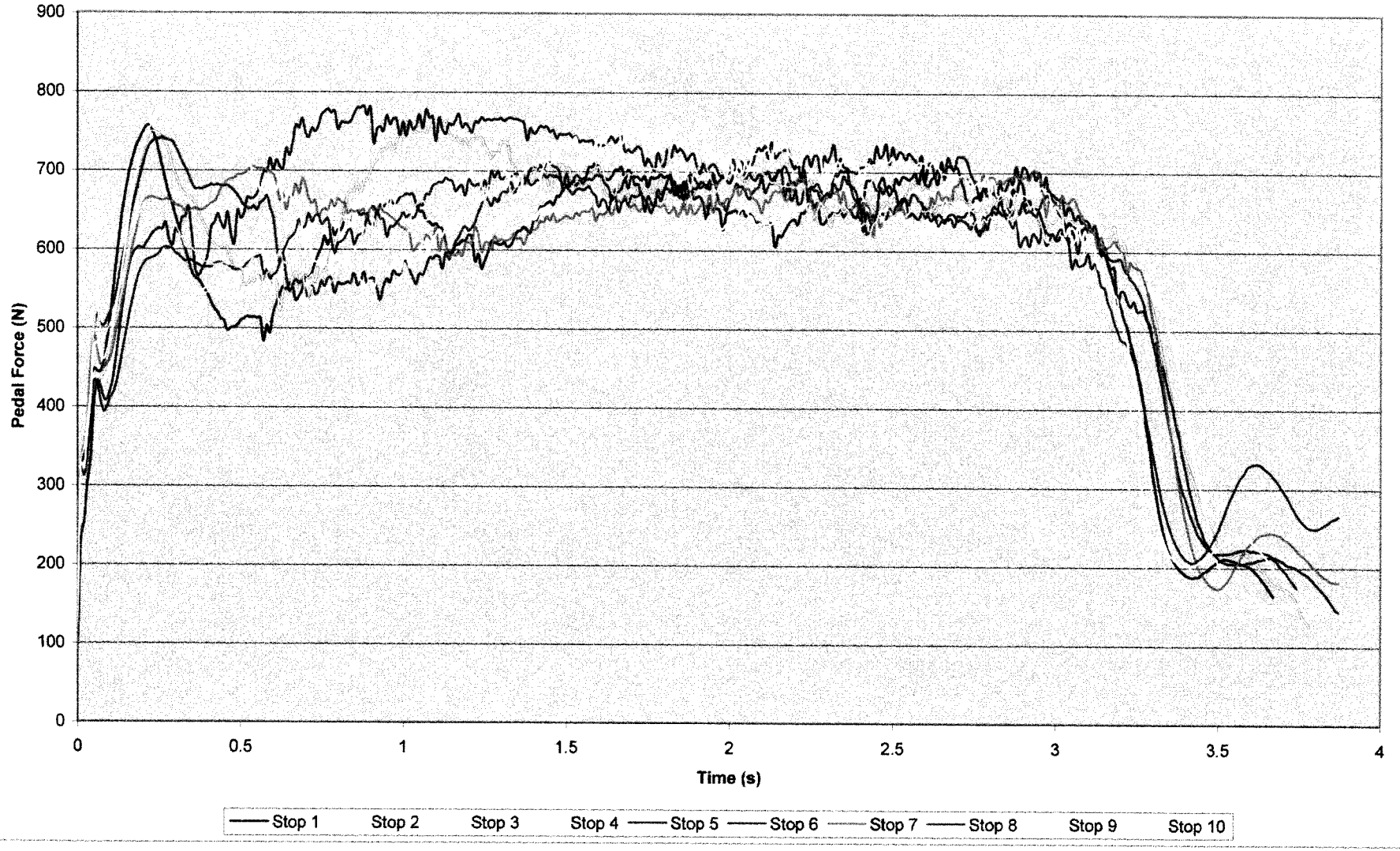
NCAP 8 - Dodge Grand Caravan - 500 N Dry



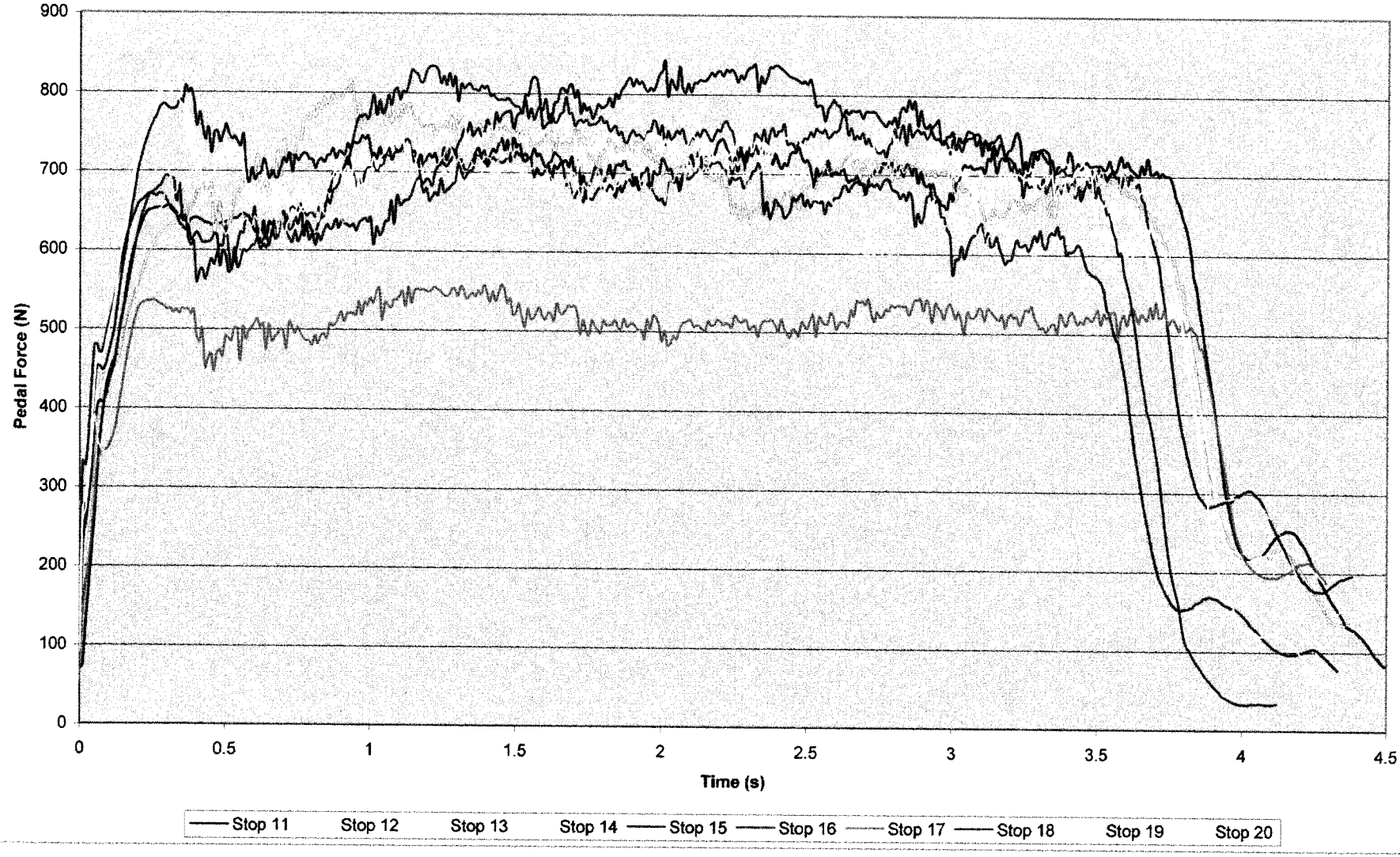
NCAP 8 - Dodge Grand Caravan - 500N Wet



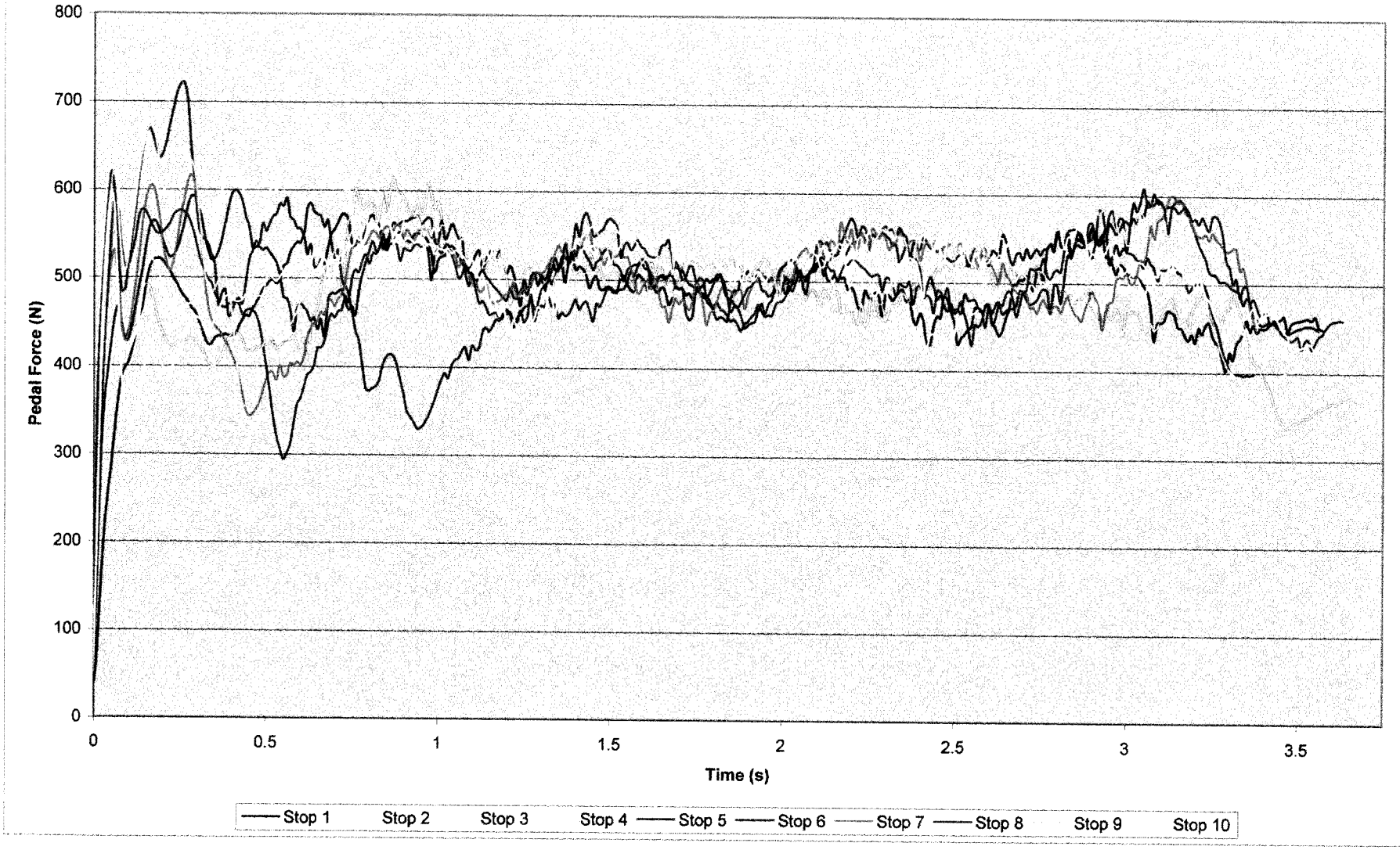
NCAP 8 - Dodge Grand Caravan - 670 N Dry



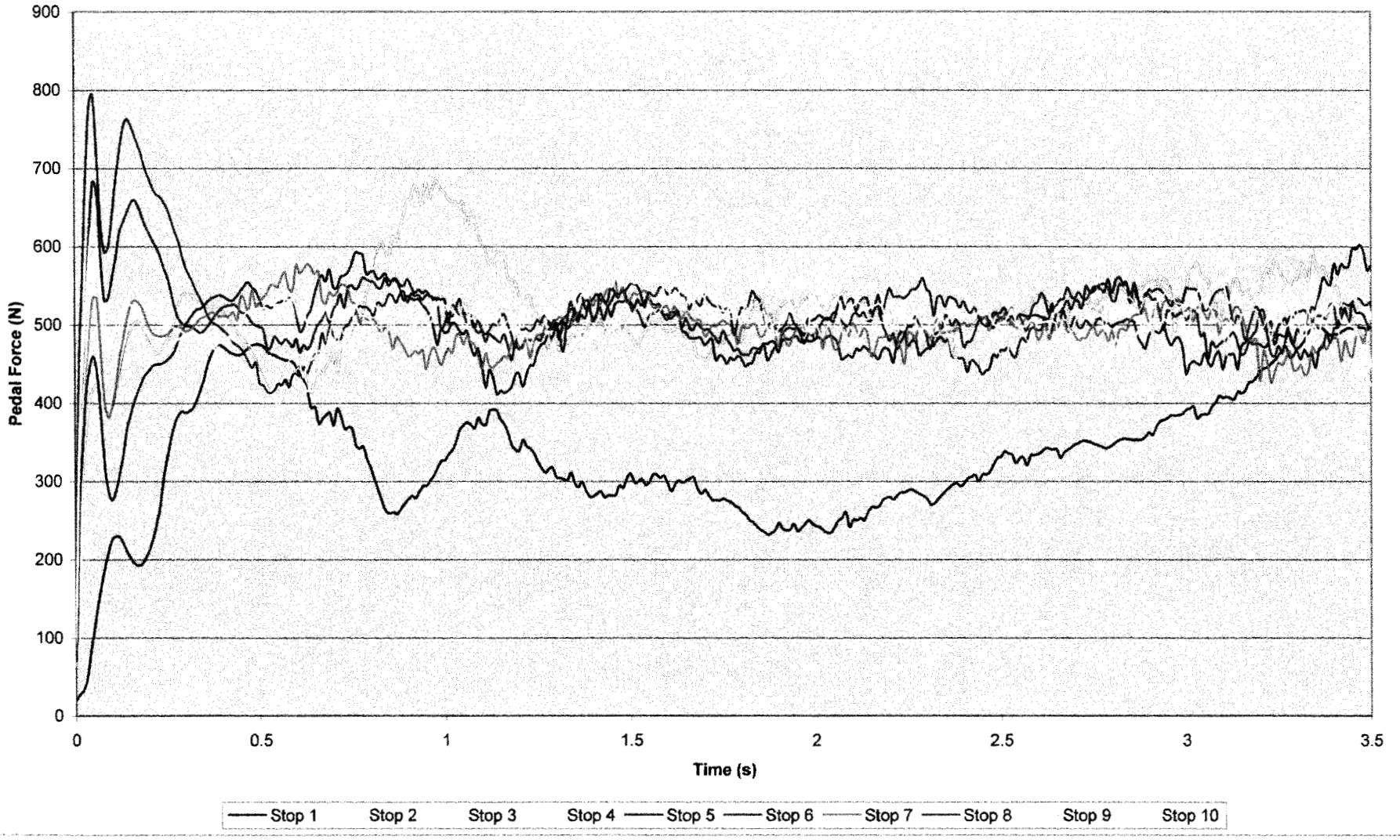
NCAP 8 - Dodge Grand Caravan - 670 N Wet



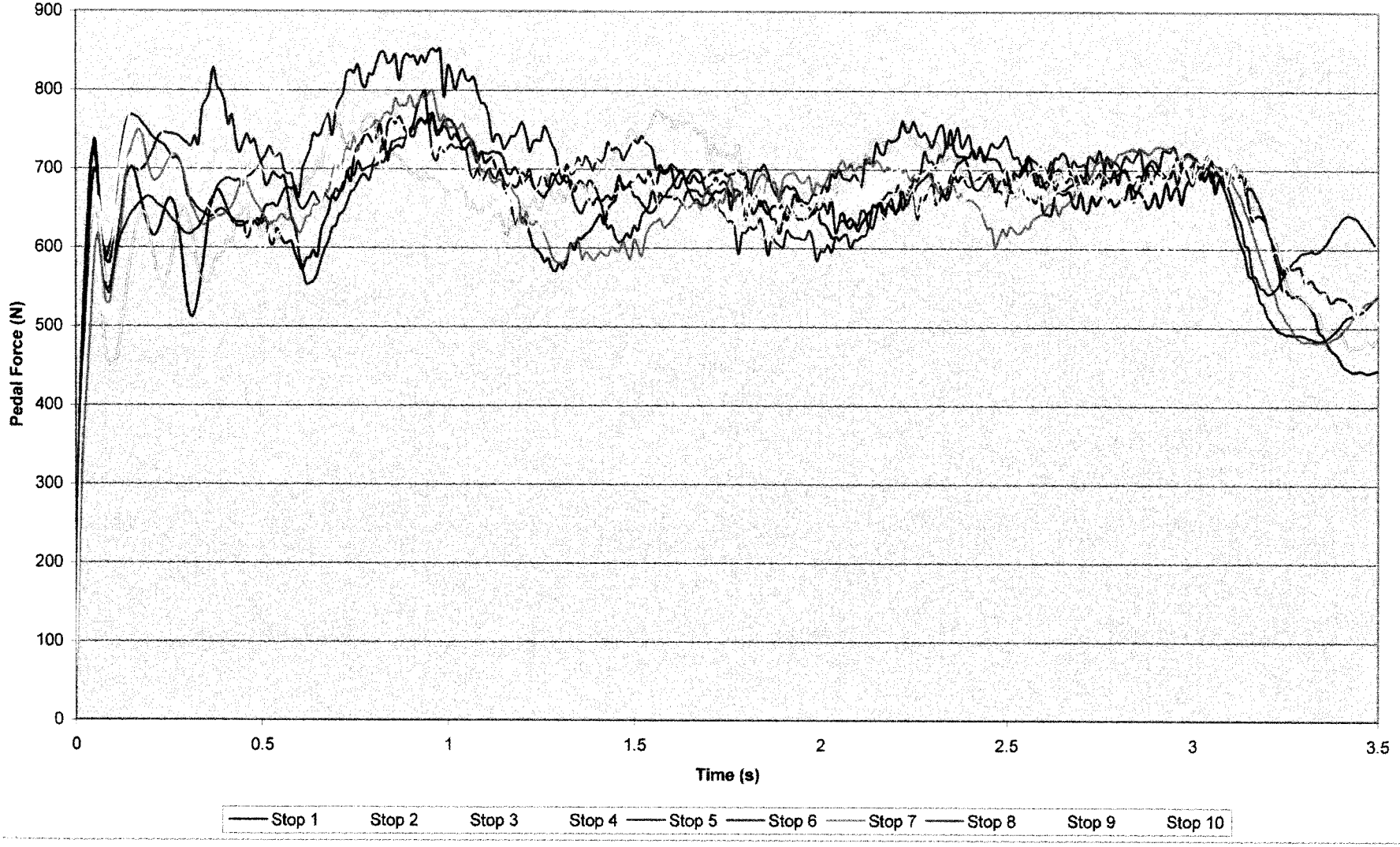
NCAP 9 - Ford Focus SE - 500 N Dry



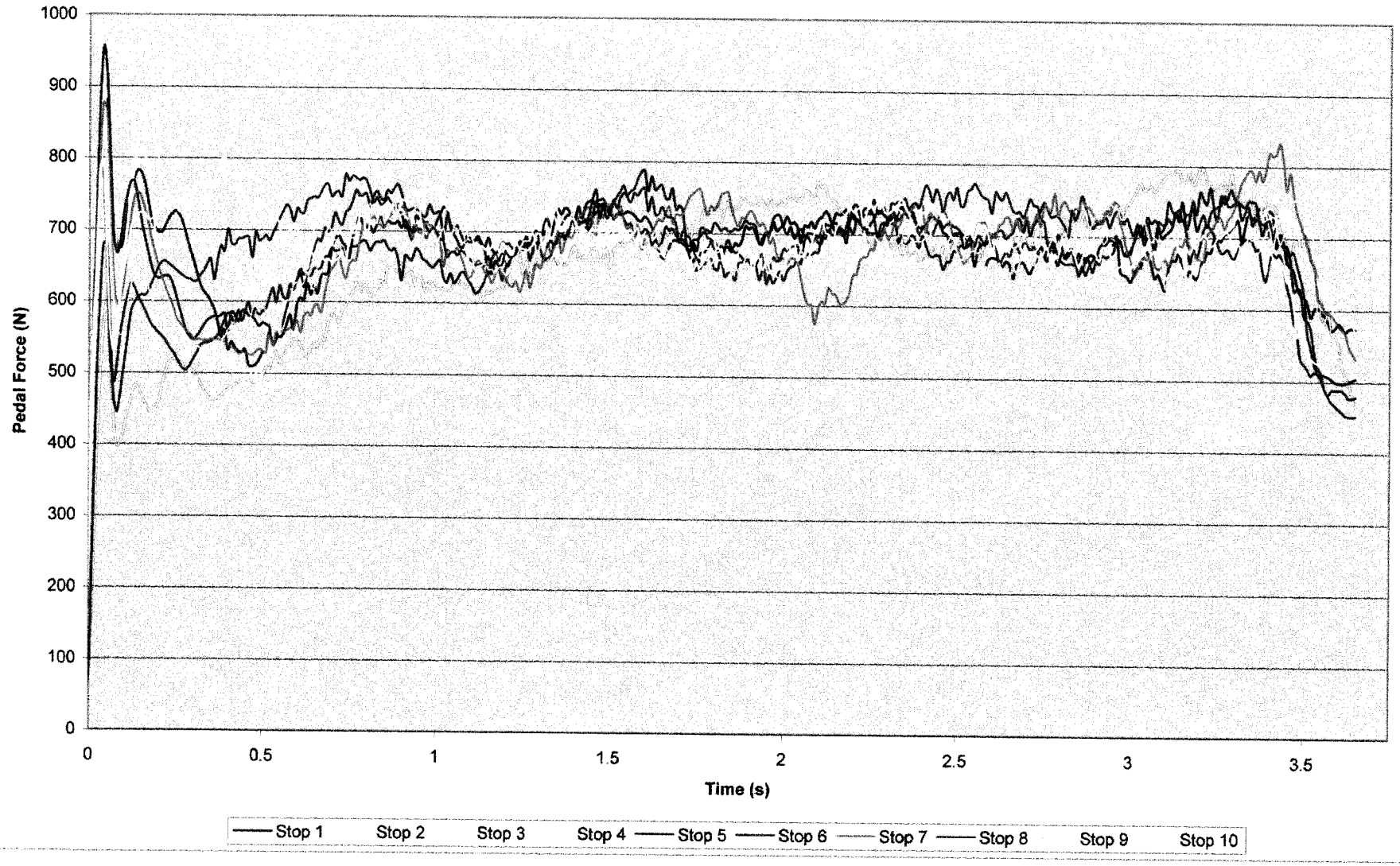
NCAP 9 - Ford Focus SE - 500 N Wet



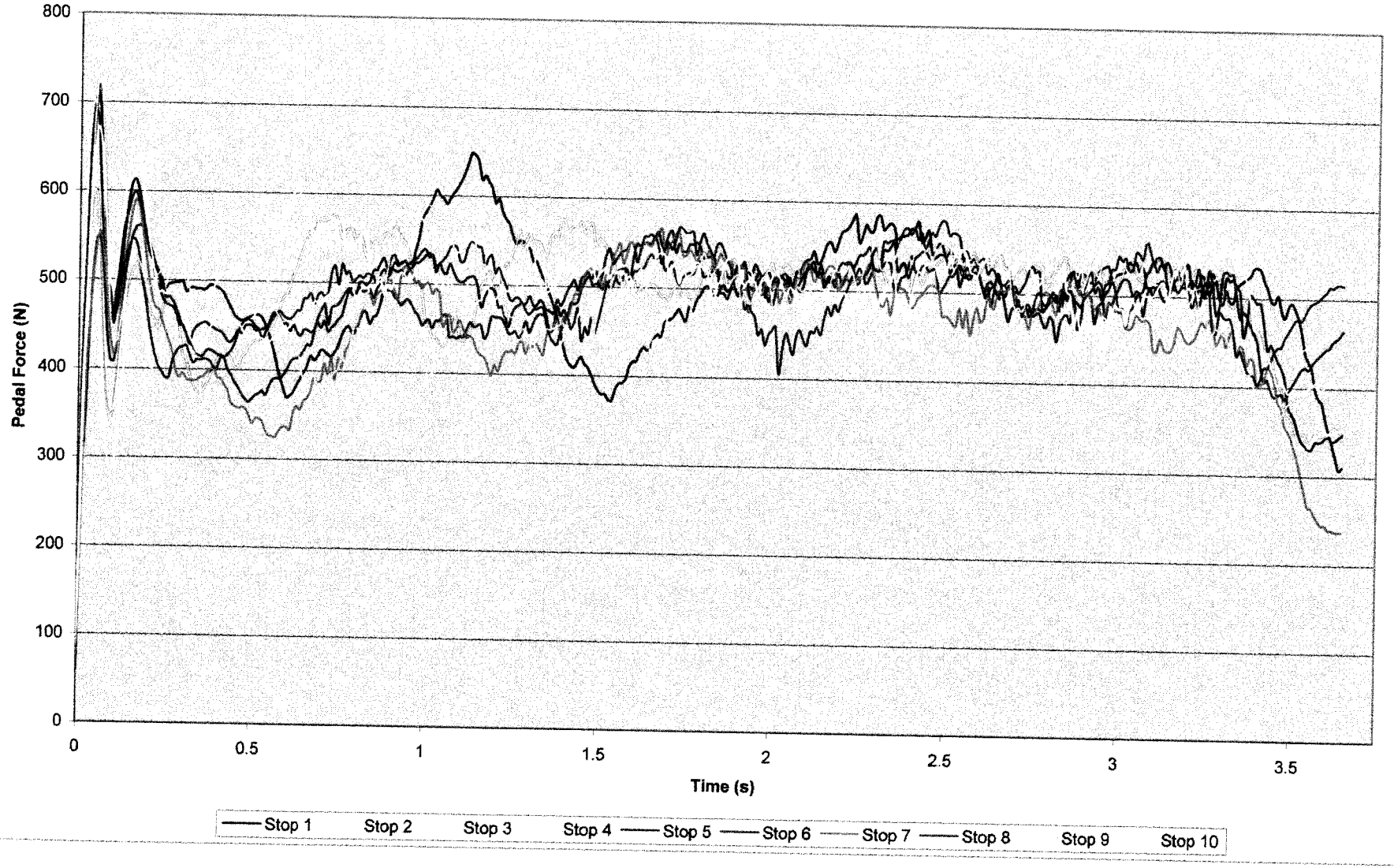
NCAP 9 - Ford Focus SE - 670 N Dry



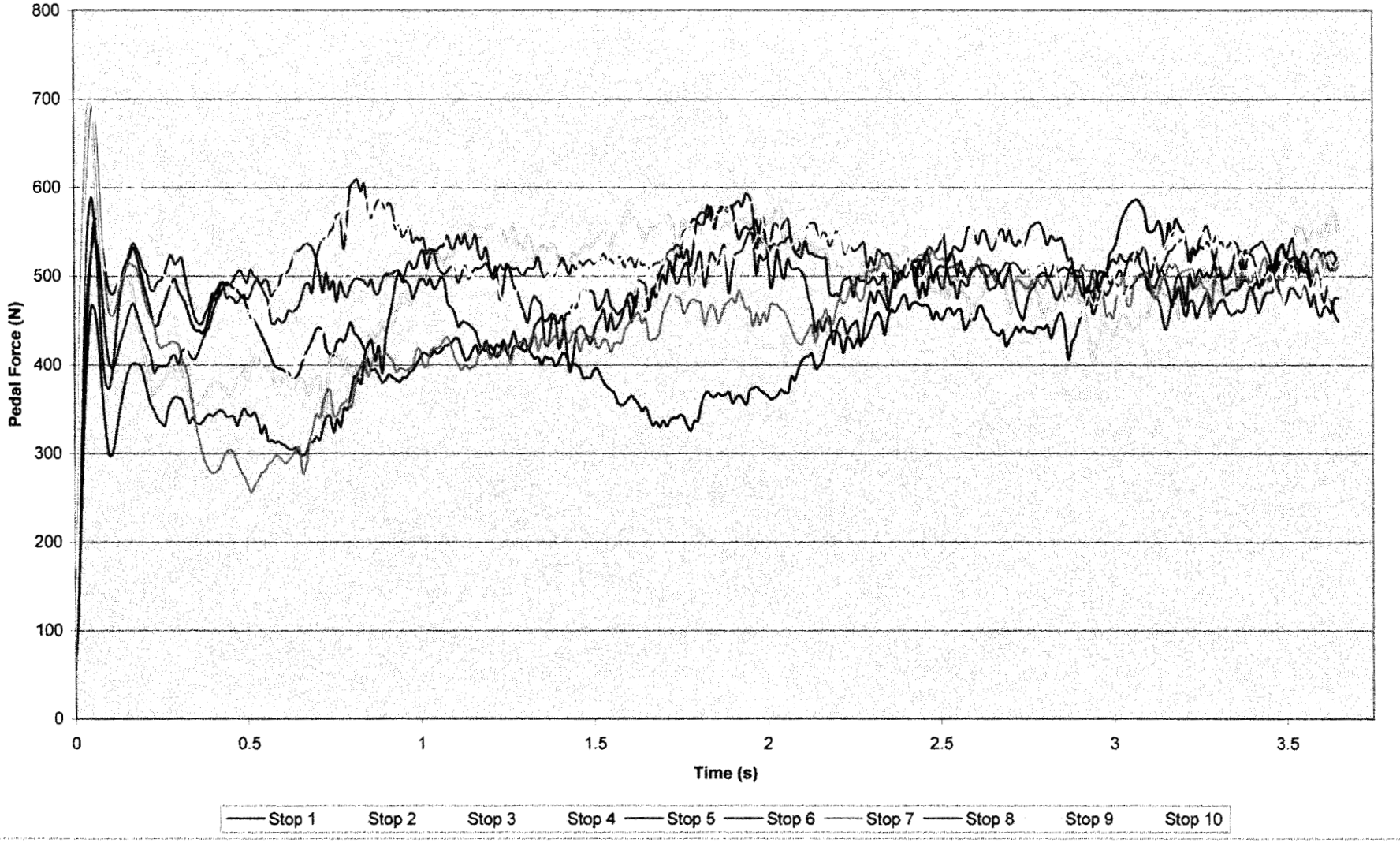
NCAP 9 - Ford Focus SE - 670 N Wet



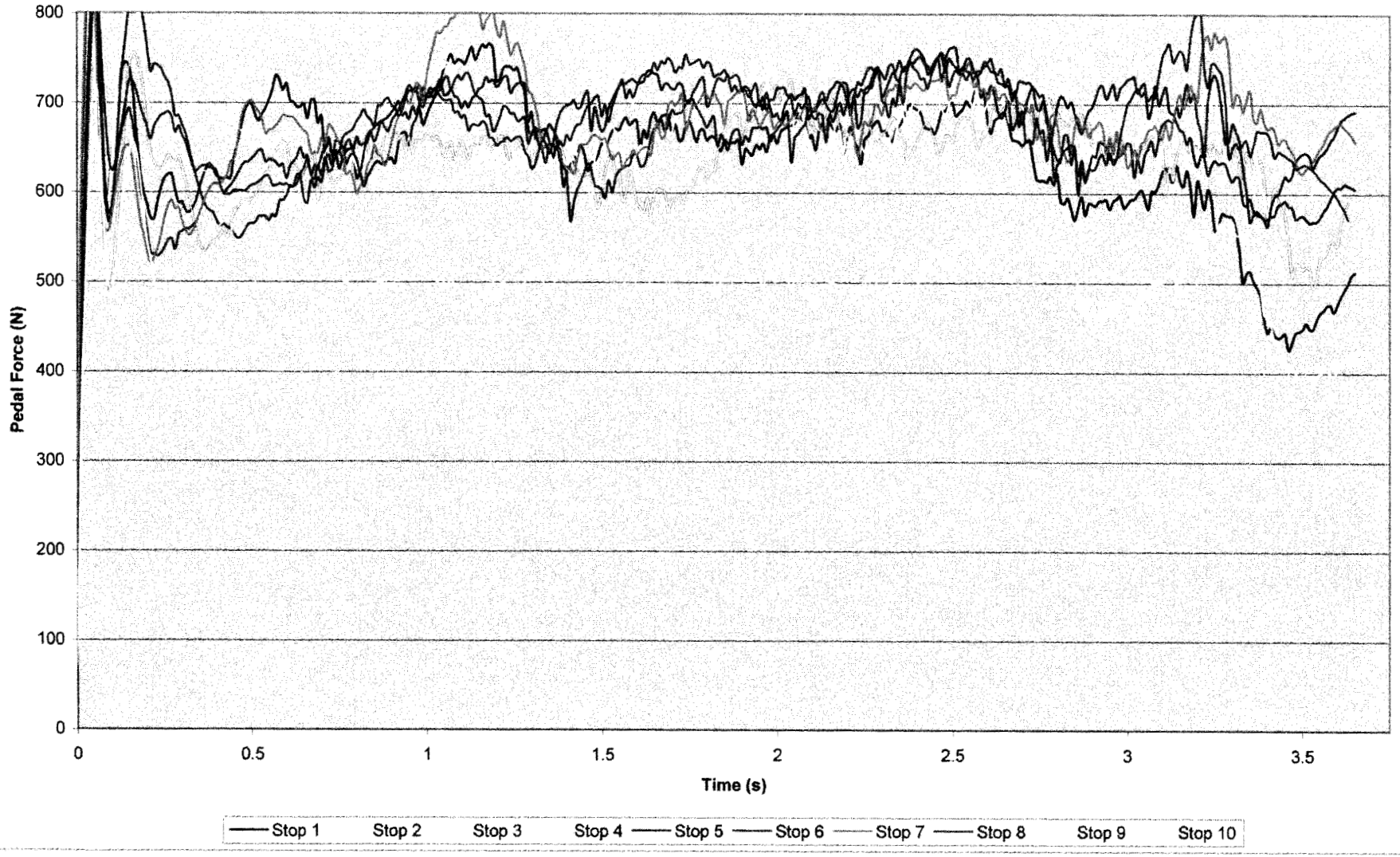
NCAP 10 - Ford Windstar SE - 500 N Dry



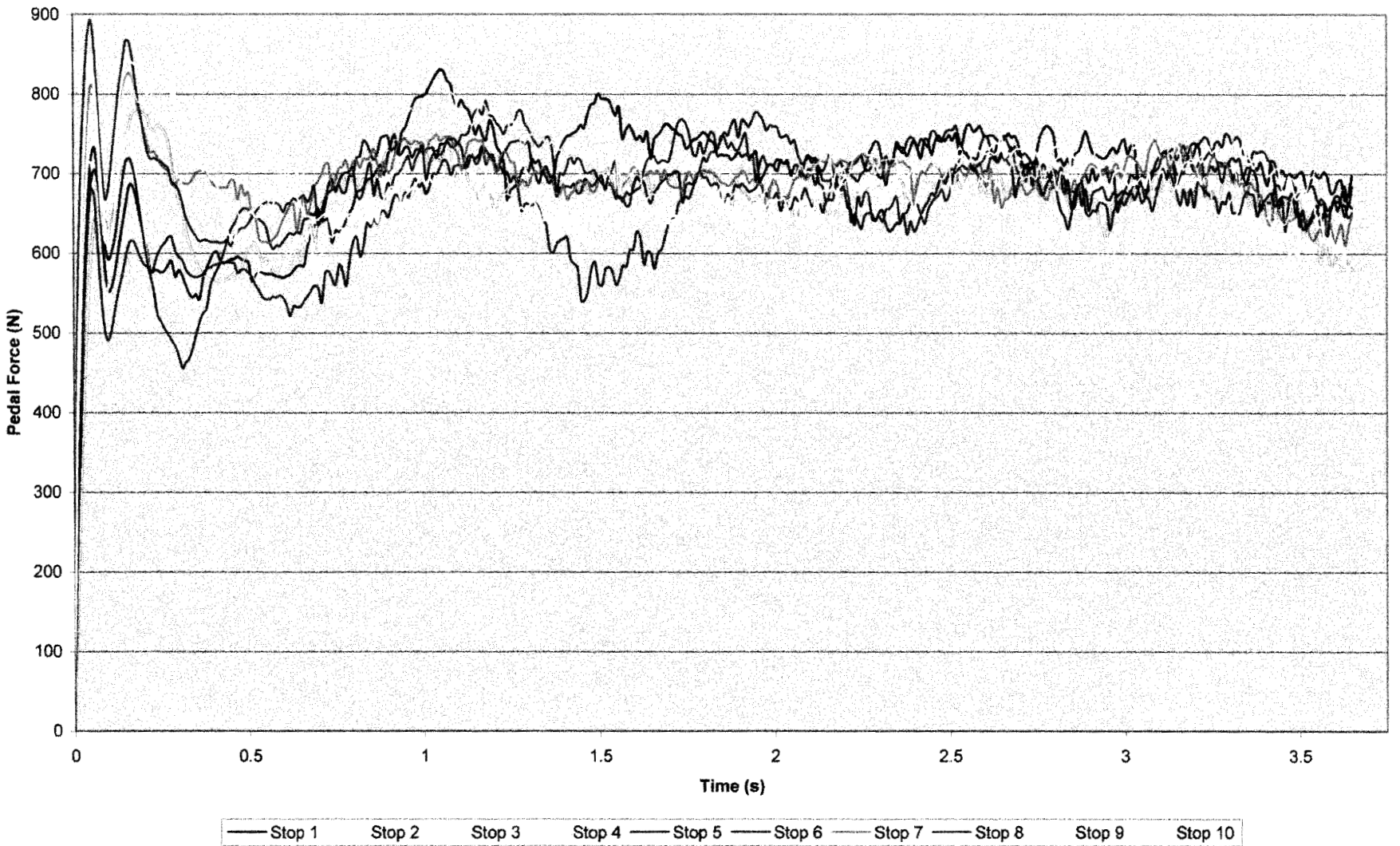
NCAP 10 - Ford Windstar SE - 500 N Wet



NCAP 10 - Ford Windstar SE - 670 N Dry



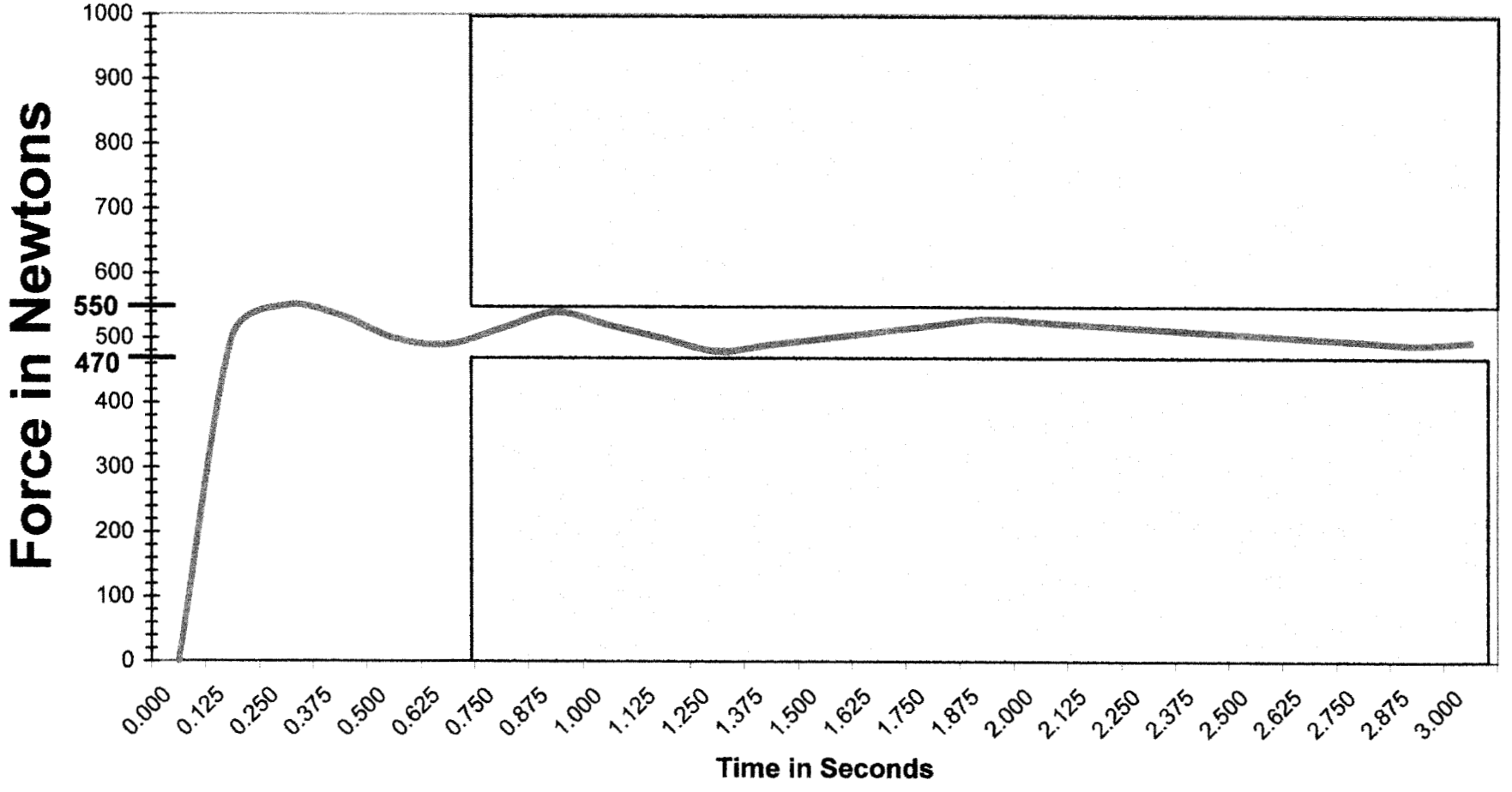
NCAP 10 - Ford Windstar SE - 670 N Wet



APPENDIX G

Recommended Brake Pedal Force Corridor Plot

PROPOSED NCAP BRAKE PEDAL FORCE CORRIDOR



APPENDIX H

Stopping Distance Statistical Information

NCAP Brake Program - Stopping Distance Statistics
Transportation Research Center - August 2003

Vehicle Number	NCAP 1	NCAP 1	NCAP 2	NCAP 2	NCAP 3	NCAP 3	NCAP 3	NCAP 3	NCAP 4	NCAP 4	NCAP 5	NCAP 5
Pedal Force Target	500	500	500	500	500	500	500	500	500	500	500	500
Surfact Condition	Dry	Wet	Dry	Wet	Dry	Dry	Wet	Wet	Dry	Wet	Dry	Dry
Raw Average	43.69	46.08	49.96	50.77	54.77	59.49	58.72	60.88	47.66	54.16	51.73	50.95
Standard Deviation	0.73	2.30	0.84	1.05	1.97	1.47	2.00	1.11	1.00	1.09	0.55	0.97
95th Confidence Interval	0.014	0.046	0.017	0.021	0.039	0.029	0.040	0.022	0.020	0.022	0.011	0.019
95th Percentile	44.68	49.78	51.14	52.00	61.94	63.16	61.32	62.54	48.97	55.46	52.46	52.44
Average Minus Outliers	43.69	45.44	49.96	50.77	57.22	57.45	58.72	60.88	47.66	54.16	51.73	50.95
Standard Deviation	0.73	1.19	0.84	1.05	1.97	1.47	2.00	1.11	1.00	1.09	0.55	0.97
95th Confidence Interval	0.014	0.025	0.017	0.021	0.039	0.029	0.040	0.022	0.020	0.022	0.011	0.019
95th Percentile	44.68	47.26	51.14	52.00	61.94	63.16	61.32	62.54	48.97	55.46	52.46	52.44
Average of First Five	43.28	45.66	49.76	50.78	58.58	57.22	59.20	61.06	47.06	54.14	51.70	51.14
Standard Deviation	0.53	1.08	0.63	0.70	1.64	0.98	2.17	1.46	0.80	1.09	0.39	1.21
95th Confidence Interval	0.015	0.030	0.018	0.020	0.046	0.027	0.061	0.041	0.022	0.031	0.011	0.034
95th Percentile	43.76	47.02	50.28	51.74	60.08	58.42	61.64	62.84	47.72	55.42	52.20	52.64
Average of Last Five	44.10	45.60	50.16	50.76	55.86	57.68	58.24	60.70	48.26	54.18	51.76	50.76
Standard Deviation	0.70	1.56	1.05	1.40	1.17	1.94	1.92	0.73	0.85	1.21	0.73	0.74
95th Confidence Interval	0.020	0.044	0.029	0.039	0.033	0.055	0.054	0.021	0.024	0.034	0.020	0.021
95th Percentile	44.80	47.28	51.34	51.94	57.44	60.28	59.60	61.54	49.04	55.34	52.48	51.64
Average of 20 Stops					57.34		59.80				51.34	
Standard Deviation					1.69		1.92				0.87	
95th Confidence Interval					0.024		0.027				0.012	
95th Percentile					60.23		61.97				52.52	
Raw Stopping Distances	42.5	44.9	50.3	50.5	60.2	56.0	61.9	63.3	47.1	53.0	51.3	52.0
	43.0	44.5	49.8	52.0	59.6	56.9	60.6	61.0	47.8	55.5	51.4	50.6
	43.5	45.7	49.8	50.7	59.2	58.6	57.4	61.0	45.7	53.5	51.8	52.8
	43.6	45.9	48.7	50.5	56.1	57.7	56.7	60.8	47.3	55.1	52.3	50.4
	43.8	47.3	50.2	50.2	57.8	56.9	59.4	59.2	47.4	53.6	51.7	49.9
	44.4	47.2	51.5	52.0	55.6	56.9	54.9	61.6	47.0	55.4	51.6	50.4
	44.9	45.1	50.7	48.5	55.6	58.2	59.2	59.8	48.6	54.6	51.6	49.8
	43.0	44.4	49.5	50.4	55.2	55.8	58.4	60.4	47.8	53.1	50.7	51.0
	44.0	44.0	50.3	51.2	57.9	60.8	59.7	60.4	49.1	55.1	52.4	51.8
	44.2	51.8	48.8	51.7	55.0	56.7	59.0	61.3	48.8	52.7	52.5	50.8

NCAP Brake Program - Stopping Distance Statistics
Transportation Research Center - August 2003

Vehicle Number	NCAP 5	NCAP 5	NCAP 5	NCAP 5	NCAP 5	NCAP 5	NCAP 6	NCAP 6	NCAP 6	NCAP 6	NCAP 7	NCAP 7
Pedal Force Target	500	500	670	670	670	670	500	500	670	670	500	500
Surfact Condition	Wet	Wet	Dry	Dry	Wet	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Raw Average	59.39	57.44	52.01	50.91	56.65	57.68	53.01	60.42	52.30	62.77	47.40	49.83
Standard Deviation	0.97	1.09	0.61	0.80	1.47	2.14	0.98	1.17	1.16	2.34	0.61	1.00
95th Confidence Interval	0.019	0.022	0.012	0.016	0.029	0.042	0.020	0.023	0.023	0.046	0.012	0.020
95th Percentile	60.60	58.76	52.72	52.04	58.61	60.33	54.03	62.16	54.01	66.47	48.39	51.31
Average Minus Outliers	59.39	57.44	52.01	50.91	56.65	57.68	53.01	60.42	52.30	62.19	47.40	49.83
Standard Deviation	0.97	1.09	0.61	0.80	1.47	2.14	0.98	1.17	1.16	1.54	0.61	1.00
95th Confidence Interval	0.019	0.022	0.012	0.016	0.029	0.042	0.020	0.023	0.023	0.032	0.012	0.020
95th Percentile	60.60	58.76	52.72	52.04	58.61	60.33	54.03	62.16	54.01	66.47	48.39	51.31
Average of First Five	59.58	57.06	51.86	50.98	57.38	57.68	52.74	60.90	51.82	61.24	47.50	50.10
Standard Deviation	0.91	1.18	0.61	1.06	1.19	2.00	1.17	1.15	1.07	1.03	0.80	1.33
95th Confidence Interval	0.026	0.033	0.017	0.030	0.033	0.056	0.033	0.032	0.030	0.029	0.022	0.037
95th Percentile	60.58	58.00	52.28	52.24	58.66	59.82	53.70	62.18	53.10	62.38	48.54	51.36
Average of Last Five	59.20	57.82	52.16	50.84	55.92	57.68	53.28	59.94	52.78	62.96	47.30	49.56
Standard Deviation	1.10	0.97	0.65	0.55	1.47	2.51	0.79	1.09	1.14	1.43	0.42	0.56
95th Confidence Interval	0.031	0.027	0.018	0.015	0.041	0.070	0.022	0.031	0.032	0.040	0.012	0.016
95th Percentile	60.50	58.78	52.82	51.30	57.94	60.34	54.14	61.36	54.24	64.48	47.88	49.98
Average of 20 Stops	58.42		51.46		57.17							
Standard Deviation	1.42		0.89		1.86							
95th Confidence Interval	0.020		0.013		0.026							
95th Percentile	60.60		52.52		60.03							
Raw Stopping Distances	60.6	56.1	52.1	50.6	58.7	60.0	53.2	60.2	50.4	59.9	46.8	51.4
	59.1	58.0	52.2	49.6	56.1	59.1	53.7	60.2	51.9	61.9	48.7	48.2
	59.1	57.7	50.8	52.4	56.4	55.3	51.0	59.8	53.4	62.5	47.2	50.3
	60.5	55.5	51.9	50.7	57.2	58.0	52.1	62.1	51.8	60.6	46.9	49.4
	58.6	58.0	52.3	51.6	58.5	56.0	53.7	62.2	51.6	61.3	47.9	51.2
	60.1	57.3	52.9	50.3	55.1	54.7	54.3	59.6	51.5	64.0	47.0	48.6
	60.6	58.7	51.7	51.3	58.5	55.5	53.2	61.6	53.2	61.7	47.0	49.9
	58.8	56.5	52.5	50.2	55.7	60.6	53.5	59.3	52.5	64.6	47.4	49.6
	58.5	58.8	51.3	51.3	55.3	58.3	52.1	60.4	52.2	63.2	48.0	50.0
	58.0	57.8	52.4	51.1	55.0	59.3	53.3	58.8	54.5	68.0	47.1	49.7

NCAP Brake Program - Stopping Distance Statistics
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Vehicle Number	NCAP 7	NCAP 7	NCAP 8	NCAP 8	NCAP 8	NCAP 8	NCAP 9	NCAP 9	NCAP 9	NCAP 9
Pedal Force Target	670	670	500	500	670	670	500	500	670	670
Surfact Condition	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Raw Average	46.19	50.77	48.04	55.04	47.21	54.51	47.52	51.57	45.51	50.31
Standard Deviation	0.77	3.76	1.75	1.34	1.12	1.29	0.87	1.50	0.92	1.23
95th Confidence Interval	0.015	0.075	0.035	0.027	0.022	0.026	0.017	0.030	0.018	0.024
95th Percentile	47.26	56.69	50.70	56.60	48.62	56.63	48.41	53.99	46.67	51.96
Average Minus Outliers	46.19	49.62	48.04	55.04	47.21	54.51	47.52	51.57	45.51	50.31
Standard Deviation	0.77	1.03	1.75	1.34	1.12	1.29	0.87	1.50	0.92	1.23
95th Confidence Interval	0.015	0.022	0.035	0.027	0.022	0.026	0.017	0.030	0.018	0.024
95th Percentile	47.26	56.69	50.70	56.60	48.62	56.63	48.41	53.99	46.67	51.96
Average of First Five	46.52	50.02	48.94	55.38	47.64	55.22	47.80	52.18	45.56	50.10
Standard Deviation	0.66	1.10	2.08	0.74	1.10	1.34	0.74	1.97	0.97	1.66
95th Confidence Interval	0.018	0.031	0.058	0.021	0.031	0.037	0.021	0.055	0.027	0.047
95th Percentile	47.22	51.24	51.42	56.34	48.72	56.78	48.46	54.16	46.68	52.16
Average of Last Five	45.86	49.18	47.14	54.70	46.78	53.80	47.24	50.96	45.46	50.52
Standard Deviation	0.78	0.69	0.71	1.80	1.08	0.82	0.98	0.51	0.99	0.73
95th Confidence Interval	0.022	0.019	0.020	0.050	0.030	0.023	0.028	0.014	0.028	0.020
95th Percentile	46.94	50.04	47.96	56.42	47.76	54.92	48.30	51.66	46.46	51.22
Average of 20 Stops Standard Deviation 95th Confidence Interval 95th Percentile										
Raw Stopping Distances	45.7	51.3	52.0	56.6	47.2	56.3	47.4	53.6	46.2	48.6
	47.3	51.0	49.1	55.3	47.8	56.9	48.3	50.0	45.5	52.5
	46.0	49.7	49.1	55.2	48.4	54.2	48.5	54.3	46.8	48.5
	46.9	48.7	48.3	55.2	46.0	54.9	46.7	50.2	44.9	50.8
	46.7	49.4	46.2	54.6	48.8	53.8	48.1	52.8	44.4	50.1
	45.5	48.4	47.8	55.5	47.2	53.4	46.5	50.7	46.5	50.9
	47.2	48.7	48.0	55.7	47.9	53.8	46.3	51.8	46.3	49.9
	45.4	50.2	46.4	52.2	47.1	53.5	48.3	50.6	44.6	51.3
	45.9	49.2	46.7	56.6	45.0	53.1	46.8	51.1	45.6	50.9
	45.3	61.1	46.8	53.5	46.7	55.2	48.3	50.6	44.3	49.6

NCAP Brake Program - Stopping Distance Statistics
Transportation Research Center - August 2003

Vehicle Number	NCAP 10	NCAP 10	NCAP 10	NCAP 10
Pedal Force Target	500	500	670	670
Surfact Condition	Dry	Wet	Dry	Wet
Raw Average	49.71	55.28	48.41	55.28
Standard Deviation	1.28	1.14	0.81	1.06
95th Confidence Interval	0.025	0.023	0.016	0.021
95th Percentile	51.61	56.98	49.64	57.03
Average Minus Outliers	49.71	55.28	48.41	55.28
Standard Deviation	1.28	1.14	0.81	1.06
95th Confidence Interval	0.025	0.023	0.016	0.021
95th Percentile	51.61	56.98	49.64	57.03
Average of First Five	50.42	55.12	48.72	55.02
Standard Deviation	1.30	1.39	0.97	1.12
95th Confidence Interval	0.037	0.039	0.027	0.031
95th Percentile	52.14	56.86	50.04	56.40
Average of Last Five	49.00	55.44	48.10	55.54
Standard Deviation	0.87	0.97	0.52	1.05
95th Confidence Interval	0.024	0.027	0.015	0.029
95th Percentile	50.12	56.54	48.68	56.98
Average of 20 Stops Standard Deviation 95th Confidence Interval 95th Percentile				
Raw Stopping Distances	52.6	53.7	48.1	53.6
	50.3	55.2	50.4	55.2
	50.3	54.0	48.5	54.9
	49.2	55.5	48.6	54.7
	49.7	57.2	48.0	56.7
	49.0	54.2	47.8	54.9
	50.4	54.8	47.5	55.0
	48.5	55.6	47.9	57.3
	49.0	55.9	48.6	54.8
	48.1	56.7	48.7	55.7

APPENDIX I

Test Surface PFC Data

NCAP PAD

PFC, dry

Run	Dates 3-21	3-26	5-1	5-19	5-27	6-10	6-30	7-21	7-31	8-20
1	0.946	0.958	0.976	0.924	0.978	0.960	0.942	0.976	0.935	0.965
2	0.966	0.922	0.918	0.986	0.964	0.909	0.955	0.954	0.937	0.958
3	0.947	0.928	0.940	0.941	0.999	0.934	0.954	0.972	0.962	0.954
4	0.983	0.922	~~0.845~~	0.952	0.910	0.890	0.975	0.949	0.953	0.945
5	0.971	0.945	0.974	0.983	0.925	0.898	0.957	0.968	0.948	0.963
6	0.948	0.978	0.959	0.988	0.969	0.971	0.911	0.928	0.962	1.003
7	0.960	0.900	0.939	0.921	0.940	0.892	0.893	0.927	0.936	0.936
8	0.968	0.909	0.941	0.955	0.951	0.905	0.944	0.939	0.953	0.942
9	0.944	0.938	~~0.826~~	~~0.893~~	0.870	0.964	0.906	0.925	0.971	0.960
10	0.975	0.923	0.969	0.983	0.926	0.963	0.939	~~0.866~~	0.952	0.964
Average	0.961	0.932	0.952	0.960	0.943	0.929	0.938	0.949	0.951	0.959
Std. Dev.	0.014	0.023	0.021	0.027	0.037	0.032	0.026	0.020	0.017	0.018

PFC, wet

1	0.843	0.827	0.785	0.849	0.825	~~0.876~~	0.848	0.885	0.837	~~0.876~~
2	0.791	~~0.742~~	0.777	0.814	0.817	0.833	0.843	0.887	0.814	0.826
3	0.839	0.834	0.814	0.801	0.868	0.842	0.814	0.889	0.817	0.798
4	0.818	~~0.733~~	0.812	0.835	0.880	~~0.738~~	0.798	0.857	0.798	0.841
5	0.801	0.816	0.774	0.815	0.796	0.811	0.828	0.882	0.802	0.776
6	0.878	0.828	0.760	0.823	0.833	0.862	0.859	0.884	~~0.871~~	0.786
7	0.798	0.825	0.780	0.861	0.879	0.814	0.842	0.847	0.779	~~0.741~~
8	0.852	0.837	0.780	0.793	0.821	0.832	0.810	0.864	0.854	0.825
9	0.887	0.836	~~0.666~~	0.837	0.797	0.774	0.786	0.845	~~0.759~~	0.762
10	0.867	0.839	0.798	0.827	0.807	0.807	0.844	0.818	0.823	~~0.719~~
Average	0.837	0.831	0.787	0.826	0.832	0.822	0.827	0.866	0.815	0.802
Std. Dev.	0.034	0.008	0.018	0.021	0.032	0.027	0.024	0.044	0.023	0.029
T_s	61/58	73	87	90	67	84/81	76/80	93	80	73

Strike-through denotes outliers

PFC, wet by water truck

	Dates			
Run	6-30	7-21	7-31	8-20
1	~~0.912~~	0.797	~~0.676~~	0.863
2	0.855	~~0.920~~	0.788	0.812
3	0.834	~~0.890~~	~~0.852~~	0.778
4	0.825	~~0.918~~	~~0.855~~	0.829
5	~~0.793~~	~~0.847~~	~~0.862~~	~~0.761~~
6	~~0.975~~	~~0.708~~	0.769	~~0.919~~
7	~~0.976~~	0.773	0.748	0.824
8	0.830	0.765	0.792	0.838
9	0.882	~~0.687~~	0.783	~~0.746~~
10	0.868	~~0.706~~	~~0.735~~	0.770
Average	0.849	0.778	0.776	0.816
Std. Dev.	0.023	0.017	0.018	0.033
T_s	80	93	84	81

Strike-through denotes outliers

Figure 5.2 Pad 4 History